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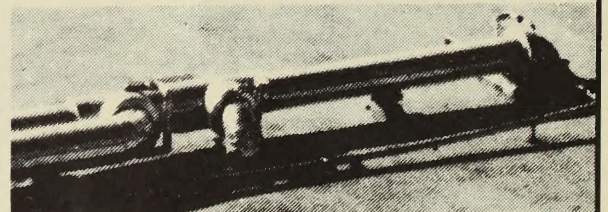
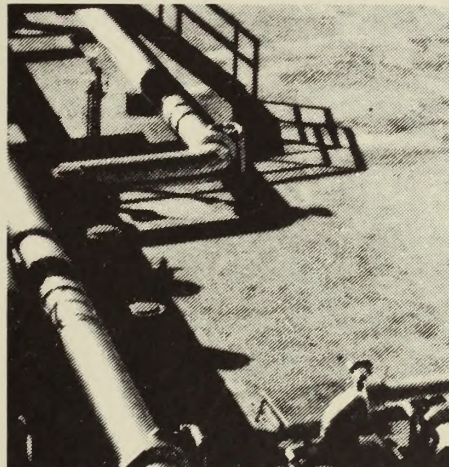
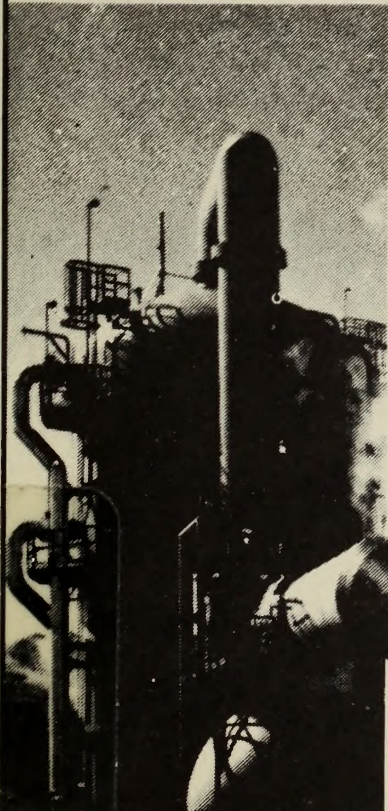
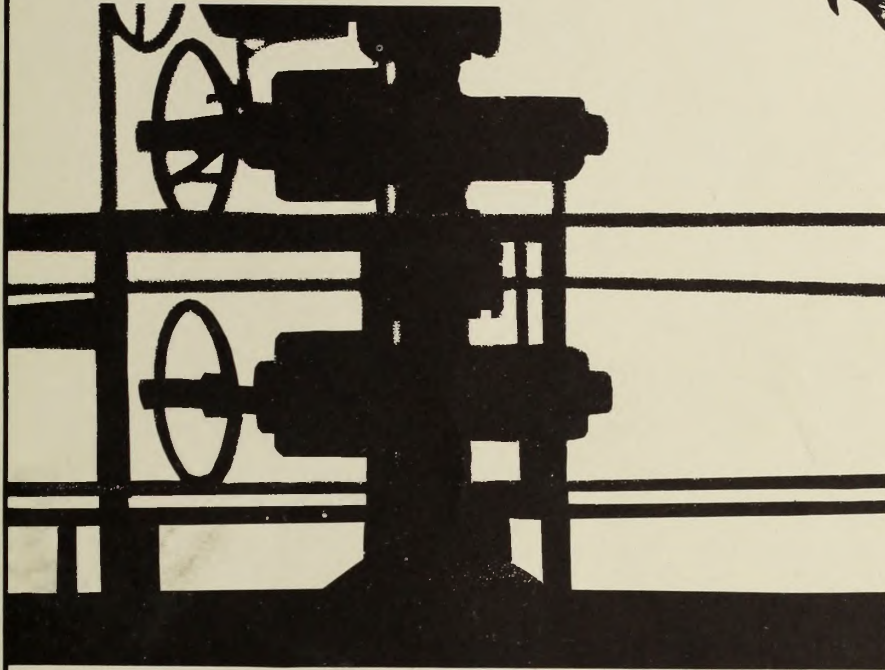
RILEY RIDGE NATURAL GAS PROJECT

WILDLIFE AND FISHERIES TECHNICAL REPORT

MAY 1983

Prepared by:
ENVIRONMENTAL RESEARCH
AND TECHNOLOGY, INC. for

DEPARTMENT OF INTERIOR
BUREAU OF LAND MANAGEMENT
DEPARTMENT OF AGRICULTURE
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FOR THE RILEY RIDGE
ENVIRONMENTAL IMPACT STATEMENT

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Principal Preparers:

Robert Sanz
Judy Armbruster
Environmental Research & Technology, Inc.
Fort Collins, Colorado

For Further Information Contact:

Bureau of Land Management
Division of Environmental Impact Statement
Services
555 Zang Street, First Floor East
Denver, Colorado 80228

This technical report was reviewed by agency specialists included in the List of Preparers in the Riley Ridge Draft Environmental Impact Statement.

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INTRODUCTION

American Quasar Petroleum Company (Quasar), Exxon Company, USA (Exxon), Northwest Pipeline Corporation (Northwest), Mobil Oil Corporation (Mobil), and Williams Exploration Company (Williams) propose to develop, produce, treat, and transport natural gas from new deep gas well fields in western Wyoming. The planned production is from previously explored but undeveloped reservoirs below 14,000 feet. The project participants are proposing to produce a significant supply of low Btu natural gas and process it to pipeline quality. The gas (called sour gas) contains methane (CH_4), carbon dioxide (CO_2), hydrogen sulfide (H_2S), nitrogen (N_2), helium (He), and other inert gases when extracted from the well fields. The sour gas would be transported by pipelines from the well fields to treatment plants where by-products and impurities would be removed and the natural (sales) gas would be prepared for shipment to available markets by sales gas pipelines. Certain by-products (CO_2 , He , and sulfur) are of commercial value if markets can be identified during the life of the project and may be transported by pipeline, truck, or rail to potential markets. Sulfur dioxide (SO_2) and N_2 would be vented to the atmosphere.

The project would consist of the construction, operation, and abandonment of the proposed well fields, gathering pipelines for the transportation of sour gas within the well fields, trunk lines for the shipment of sour gas from the terminus of the well field gathering systems to the proposed treatment plants, the treatment plants, sales gas pipelines for shipment of sweet gas to existing main pipelines, and facilities for the handling and transportation of by-products removed during the treatment process to proposed markets.

The Riley Ridge Project area is located in southwestern Wyoming in Sublette, Lincoln, and Sweetwater counties. Major physiographic features of the region include the Wyoming Range extending in a north-south direction west of the proposed project, the Wind River Range east of the project area, and the Green River approximately 13 miles east of the proposed well field. Numerous creeks drain the area and flow eastward to the Green River. Nearby towns include Big Piney, Marbleton, and LaBarge, all of which are located east of the well field along U.S. Highway 189, and Opal and Kemmerer which are located southwest of the southern treatment plant sites. Portions of the proposed well field are located in the Bridger-Teton National Forest and the BLM Rock Springs District, while the balance of the project is located on other public, state, and privately owned land. The Riley Ridge Project area refers to the general region including the Wyoming Range and the Upper Green River basin, south to Highway 80. The study area refers to the well field, plant sites, and corridors. The area involves approximately 496,000 acres, 159,928 of which are within the well field.

This wildlife technical report was prepared by ERT as a preliminary step in the EIS preparation process. It provides detailed information on the wildlife resources of potentially affected areas and discusses the impacts of proposed and alternative actions on these resources. The complexities of the Riley Ridge Project with its multiple applicants and varied development

scenarios, in combination with the very large size of the potentially affected environment and the richness of the area's wildlife resources, all contribute to the necessity of focusing impact assessment efforts on the significant issues identified to date through agency and public scoping. This report is organized in a manner that will aid the reader in identifying those issues and the comparative impacts of alternative developments.

The wildlife report is one of a series of eight technical reports prepared by ERT as background and documentary material for the EIS. Each report presents a summary of studies of the affected environments and results of impact analyses. A detailed description of the project can be found in Chapter 1, "Description of Proposed Action and Alternatives", within the EIS and the Proposed Action Technical Report. Chapter 1 of this technical report addresses important wildlife resources within the affected environment. Chapter 2 describes the environmental consequences of the proposed and alternative actions on those resources, and Chapter 3 presents the methods used in collecting information and performing analyses.

This chapter is in two sections and provides a description of the affected environment. The first deals with the regional setting, emphasizing primarily well field habitats and important wildlife groups, but also including important habitats and wildlife associated with off-well field plant sites and corridors. The second section consists of a brief comparative presentation of key specific wildlife or habitat characteristics as related to various well field units, plant sites, and transportation corridors.

OVERVIEW

The Riley Ridge Project area is rich in wildlife resources. Varying topography, elevation, precipitation, soils, and associated plant communities support a diverse wildlife community composed of species typical of coniferous and aspen forests, sagebrush steppe, mountain shrub and bunchgrass slopes, greasewood and saltbush flats, agricultural pasture and hayfields, riparian zones of wet meadow, willow, and cottonwood types, and aquatic habitats varying from small mountain streams to beaver ponds, stock ponds, small reservoirs, larger streams, and a major river system and reservoir.

The area is well known for its diversity of big game and is an important recreation area for sport hunting. Managing the wildlife resource has been and continues to be a major objective of the Wyoming Game and Fish Department (WGF). The Forest Service (FS), and Bureau of Land Management (BLM) are responsible for managing wildlife habitat. Populations of elk, moose, mule deer, and pronghorn are all hunted in the area, and the continued welfare of these species has been identified as a significant issue related to oil and gas development. Bighorn sheep have been reintroduced in a portion of the proposed well field and propagation of that population and maintenance of its habitat is also an important issue. Other trophy game includes black bear and mountain lion. Wild horses occur over much of the area. Four species of federally protected endangered status have been reported to occur in the study area: bald eagle, whooping crane, black-footed ferret, and peregrine falcon. Sage grouse, blue grouse, ruffed grouse, chukar, and mourning dove are the area's upland game birds. Important waterfowl include Canada goose, mallard, and blue-winged teal and others. Small game mammals are the cottontail, snowshoe hare, and red squirrel. Other groups of interest are raptors and birds such as the sandhill crane and long-billed curlew. Beaver occupy many of the drainages and numerous other species of furbearers, small mammals, songbirds, reptiles, and amphibians inhabit the area.

HABITATS

Vegetation studies have delineated 15 vegetation types in the study area [Environmental Impact Statement (EIS) Soils and Vegetation Section]. For the purposes of wildlife habitat discussions, several have been consolidated resulting in 12 general wildlife habitat types. Table 1-1 lists the major

TABLE 1-1
ACRES OF WILDLIFE HABITATS WITHIN THE RILEY RIDGE STUDY AREA BY PROJECT COMPONENT

Wildlife Habitat Type	WELL FIELD UNITS AND AREAS										Total
	Proposed Darby Mountain ¹	Proposed N. Riley Ridge ¹	Riley Ridge	Lake Ridge	Fogarty Creek	Dry Piney	Graphite	Sawmill Area ²	Tip Top	Hogsback	
Conifer	11,788	7,609	3,155	11,997	4,813	1,018	1,522	102	89	666	42,759 26%**
Clearcut	1,235	134	448	326	45	6	352	-	-	-	2,546 2%
Aspen	134	2,803	1,139	973	1,395	672	429	1,203	358	26	9,132 6%
Sagebrush	986	4,712	8,857	5,524	7,772	5,207	774	10,608	27,718	9,017	81,175 51%
Mountain shrub	538	-	-	-	-	-	-	-	634	538	1,710 1%
Bunchgrass/Forb	1,370	2,400	1,427	1,274	1,408	115	550	269	896	806	10,515 7%
Greasewood	-	-	-	-	-	-	-	-	256	-	256 <1%
Saltbush	-	-	-	-	-	-	-	-	-	-	-
Pasture/Hayfield	-	198	435	-	166	26	-	3,712	1,210	-	5,747 3%
Riparian	442	1,024	557	896	262	237	-	1,332	679	179	5,608 3%
Aquatic	70	-	-	-	-	-	-	-	-	-	70 <1%
Mixed desert shrub	-	-	-	-	-	-	-	-	-	-	-
Barren/Disturbed	397 ⁶	-	-	-	-	-	13	-	-	-	410 <1%
TOTAL	16,960	18,880	16,018	20,990	15,861	7,281	3,640	17,226	31,840	11,232	159,928

*Percent of total within the well field.

TABLE 1-1 (CONTINUED)

Habitat Type	NON-LINEAR FACILITIES ^{4, 5}												
	EDB ³ (AQ)	EDB (Ex)	WDB ³ (Ex)	BM ³ (Ex)	CC ³ (NWP)	BH (AQ)	SC (Ex)	SL ³ (Ex)	C-BM (Ex)	C-SC (Ex)	C-WDB (Ex)	C-EDB (AQ)	C-BH (AQ)
Conifer	-	-	-	-	-	-	-	-	-	-	-	-	-
Clearcut	-	-	-	-	-	-	-	-	-	-	-	-	-
Aspen	-	-	-	-	-	-	-	-	-	-	-	-	-
Sagebrush	483	640	635	506	496	640	-	22	320	-	320	320	320
Mountain shrub	-	-	-	26	-	-	-	-	-	-	-	-	-
Bunchgrass/Forb	-	-	5	108	-	-	463	-	-	-	-	-	-
Greasewood	-	-	-	-	-	-	-	-	-	-	-	-	-
Saltbush	157	-	-	-	-	-	-	125	-	-	-	-	-
Pasture/Hayfield	-	-	-	-	-	-	-	-	-	-	-	-	-
Riparian	-	-	-	-	-	-	-	34	-	-	-	-	-
Aquatic	-	-	-	-	-	-	-	-	-	-	-	-	-
Mixed desert Shrub	-	-	-	-	144	-	177	-	-	320	-	-	-
Barren/Disturbed ⁶	-	-	-	-	-	-	-	59	-	-	-	-	-
TOTAL	640	640	640	640	640	640	640	240	320	320	320	320	320

¹Proposed units.²Former unit.³Indicates part of Proposed Action, other facilities are alternatives or component alternatives.⁴Transportation corridor vegetation was determined by linear analysis. These are presented in Chapter 2.

⁵EDB - East Dry Basin Plant Site
WDB - West Dry Basin Plant Site
BM - Big Mesa Plant Site
CC - Craven Creek Plant Site
BH - Buckhorn Plant Site
SL - Shute Creek Plant Site
EX - American Quasar
NWP - Northwest Pipeline

C-BM - Big Mesa Construction Camp

⁶Barren - high altitude talus slopes with little or no vegetation
Disturbed - abandoned gravel pit.

wildlife habitats and presents their acreages within the well field and non-linear project components study area. Characteristics of these habitats as they pertain to wildlife are described below.

Coniferous Forest

Four major vegetation types make up the coniferous forest habitat in the study area; these include lodgepole pine, spruce/fir, mixed pine, and Douglas-fir. Coniferous forest occurs on 26 percent of the well field and is limited to the higher elevations (8,000 to 10,000 feet) within the well field. Most of the forested lands occur within the Big Piney District of the Bridger-Teton National Forest.

These lands provide important cover for elk in the region. Several other species including mule deer, black bear, and moose also depend on forest stands during part or all of the year. Several FS management indicator species (MIS-a designation which uses these species as an indicator of habitat quality), including the hermit thrush, ruby-crowned kinglet, goshawk, and marten are dependent on forest habitats. These species depend primarily on old growth spruce/fir or Douglas fir timber stands. The abundance of snags and down-deadwood material in old growth stands furnish nesting and foraging habitat for many insectivorous birds. In the study area old growth timber occurs on Deadline Ridge and Mount Darby, north-facing slopes at lower elevations, east-facing slopes at higher elevations, and scattered stands throughout the area. Several other species of nongame wildlife including songbirds like the black-capped chickadee and Clark's nutcracker, and small mammals such as the red squirrel, yellow-pine chipmunks, and red-backed vole are common in forest habitats. Blue grouse depend on forested communities, and other species like the porcupine occur in some parts of the forest.

Clearcut

Clearcuts occur throughout the forested portions of the study area. No mature trees are present and the understory consists of a variety of herbaceous species, scattered shrubs, and coniferous saplings. The abundant understory provides important forage for elk and mule deer, especially where timber surrounding clearcuts provides security cover. Clearcuts represent about 2 percent of the well field study area. The tall herbaceous forbs provide food and brood cover for blue and ruffed grouse. Small mammals are usually abundant in these productive areas, making clearcuts excellent hunting areas for raptors. Timber harvest in the Big Piney District and adjacent BLM lands has, in recent years, been managed to improve wildlife habitats by creating structural diversity, maximum interspersions, and optimizing habitat value.

Aspen

These communities are common at middle elevations (8,500 to 9,000 feet), occurring as even aged stands on deeper soils on all slope aspects. The understory may contain seedlings and saplings of Englemann spruce and subalpine fir. Ground cover is estimated to be about 90 percent. The aspen communities average much greater productivity levels than the coniferous communities and consequently provide valuable forage as well as cover for wildlife and livestock. They are generally regarded as very rich and diverse wildlife areas, excelled only by riparian and wetland types. On BLM

lands at lower elevations (where cover is sparse) aspen provide important seasonal cover for elk and other large mammals. Aspen communities occur over 6 percent of the well field study area. Aspen stands provide important habitat for ruffed grouse, warbling vireo, and western jumping mouse (all MIS species). Beaver utilize aspen and willows along small creeks for food and building material; beaver ponds provide habitat for many other species. Porcupine, northern pocket gophers, and long-tailed voles also commonly occur in aspen communities. Aspen communities are often inaccessible due to snow in winter but provide important forage and cover to mule deer throughout the rest of the year. Elk use aspen and adjacent conifer and/or sagebrush for calving.

Sagebrush

Sagebrush is the predominant vegetation type within the study area and accounts for 51 percent of the well field area. Two types of sagebrush communities are recognized, mapped, and discussed in the Soils, Vegetation, and Reclamation Technical Report. These include a big sagebrush type occurring on deeper soils on ridgetops, basins and sideslopes; and a sagebrush complex which is a mosaic of big, low, and black sagebrush occurring on shallow soils.

Sagebrush provides important habitat for several species including game species like sage grouse, pronghorn, and mule deer, and to some extent elk and moose; songbirds like Brewer's sparrow (MIS), sage sparrow, vesper sparrow, and sage thrasher; and small mammals like the white-tailed jackrabbit, Richardson's ground squirrel, northern grasshopper mouse (MIS), and sagebrush vole (MIS). Evidence of badger, white-tailed prairie dogs, and pocket gophers were also observed in the sagebrush habitat.

At lower elevations, dense stands of sagebrush provide critical winter range for mule deer. Elk and moose also use sagebrush as feeding sites. Sagebrush areas are also leased extensively for livestock grazing, and a herd of about 50 to 100 wild horses occupy sagebrush habitat on BLM lands. The 1982 BLM horse counts showed 55 horses in 10 bands.

Mountain Shrub

Mountain shrub habitats composed of mountain mahogany, snowberry, serviceberry, and ceanothus occur over 1 percent of the well field study area. The mountain shrub habitat occurs on steep slopes on the leeward side of ridges in the well field. The mountain shrub habitat provides habitat for songbirds like the dusky flycatcher, green-tailed towhee, and blue-gray gnatcatcher. Mule deer also use this habitat year round and it is important for browse for deer in winter on critical winter ranges.

Bunchgrass - Forb

This low-growing grassland habitat occurs over 7 percent of the well field. It occurs on wind-swept and south-facing slopes primarily at elevations between 8,000 and 8,500 feet, and up to 10,800 feet. This single stratum community occurs on rocky, shallow soils and is dominated by grasses and forbs. This habitat provides forage for deer, elk, and livestock. On Fish Creek Mountain and Mount Darby, this type provides winter range for bighorn sheep and begins to take on alpine characteristics. Higher elevations support important elk forage species such as balsam root and monument plant,

while lower elevations (such as Middle Piney Creek) support sweet vetch and penstemon. At lower elevations this type borders aspen and sagebrush and provides habitat for species like the white-tailed jackrabbit and horned lark.

Greasewood

Greasewood habitat occurs primarily on lower elevations in the well field and accounts for <1 percent of the well field study area. Greasewood is often mixed with sagebrush. Winterfat is typical of this type, and is a valuable forage species for mule deer in the winter. Compared to other vegetation communities, greasewood stands are less productive and less desirable habitats for wildlife. They provide habitat for jackrabbits, pronghorn, and small species such as the least chipmunk, northern grasshopper mouse, and deer mouse.

Saltbush

This habitat occurs primarily along the transportation corridors on basin floors and alkaline soils. Like greasewood, it is less productive than other habitats and supports less wildlife diversity but is important to pronghorn, jackrabbits, and to some extent mule deer, which feed on winterfat and saltbush in this habitat.

Mixed Desert Shrub

This habitat occurs in the southeastern study area corridors towards Rock Springs. This region contains a unique plant community with scattered sand dunes occurring on a saline clay basin. The dunes are dominated by rubber rabbit brush, spiny hopsage, and big sagebrush with horsebrush and indian ricegrass in the understory. The saline clay basin areas between the dunes are dominated by Gardner saltbush, thickspike wheatgrass, and shadscale. This type also supports winterfat, an important forage species. These areas serve as habitat for pronghorn, white-tailed prairie dogs, sage sparrow, and green-tailed towhee.

Pasture/Hayfields

Pastures and irrigated hayfields occur along major drainages within the well field at lower elevations. This habitat accounts for 3 percent of the well field study area. Areas containing grasses, rushes, sedges, and willows support many of the species found in riparian habitats. Seasonally flooded hayfields are a valuable wetland type for waterbird foraging. In addition, species adapted to agriculture areas such as the striped skunk, raccoon, red fox, western kingbird, western meadowlark, American kestrel, mourning dove, badger, and muskrat also may occur here. In the past many of these areas were critical winter range for elk; however, elk are now fed on feedgrounds in the area to reduce damage to crops. Some problems with elk damaging pasture and haystacks still occur when elk, wintering on natural winter ranges, are pushed to lower elevations by severe winter conditions or by human disturbance such as snowmobiles or traffic associated with current oil and gas development.

Riparian

Three major types of riparian communities occur within the study area; these include cottonwood, willow, and wet meadow. At higher elevations springs and seeps are often bordered by mixed stands of willow and aspen. At middle

elevations and along small streams and irrigation canals, willows are common. Wet meadows occur at seeps, springs, and flooded bottoms. Cottonwoods are dominant at lower elevations where floodplains are wider and soils deeper (such as along South Piney Creek and the Green River). Riparian communities are very rich and productive habitat and are limited in the study area.

Together these types represent 3 percent of the total well field study area. Riparian communities make up a very small portion of the total area, however, their importance to wildlife and livestock cannot be over emphasized. Several species of wildlife depend on the free water as well as the productive understory for food and cover. Undisturbed stream bottoms with dense stands of willows and aquatic macrophytes provide habitat for moose. Willow communities provide habitat for many species including the willow flycatcher, white-crowned sparrow, and beaver, all recognized as MIS species by the FS. Willows also provide important streambank protection to watersheds from excessive erosion and sedimentation, while providing shade and cover for fish in the aquatic system.

Wet meadows are highly productive habitats in the study area supporting livestock grazing as well as habitat for small mammals like the northern water shrew and meadow vole (MIS species). Raptors like the red-tailed hawk, marsh hawk, and American kestrel frequently hunt these areas. Wet meadows, seeps, and springs are very important for sagegrouse during the brood-rearing and later summer periods, especially when located in the drier sagebrush areas. Sandhill cranes often stop in wet meadow areas and use major creek bottoms and wetlands along the Green River for breeding or staging during migration, so these areas are potential habitat for whooping cranes. Wet meadows near shallow streams are a major habitat frequented by long-billed curlews in western Wyoming. Wet meadows provide reproductive areas for a variety of insects, amphibians, and reptiles which in turn support a variety of waterbirds such as spotted sandpiper and long-billed dowitcher.

On major waterways like the Green River, cottonwoods provide roost sites for wintering bald eagles, heronries for great blue herons and nest sites for raptors. Upper portions of the Green River may provide habitat for osprey, whistling swan, trumpeter swan, and belted kingfisher. Swallows and red-winged blackbirds are common species near stock ponds and marshes.

Aquatic

Aquatic habitats in the study area consist of rivers, streams, lakes, beaver ponds, irrigation canals and reservoirs. Most of the perennial streams draining the study area support beaver and contain numerous small beaver ponds which create ideal habitat for dabbling ducks and other birds, and trout (especially the Colorado River cutthroat trout, a MIS species). A discussion of fishery resources, habitats, and macroinvertebrates is included in the Fisheries portion of this Technical Report. The small streams and irrigation canals provide habitat for muskrat, amphibians, and reptiles. The major water bodies in the project area include Middle Piney Lake, Sixty-Seven Reservoir, and Fontenelle Reservoir. All streams in the study area are tributaries to the Upper Green River. Sixty-Seven Reservoir and Fontenelle Reservoir provide open water and resting habitat for

migratory waterfowl and some nesting habitat for waterfowl such as Canada goose, mallard, and green-winged teal.

Special Status Areas

The Seedskadee National Wildlife Refuge is an area of 14,376 acres about 5 miles downstream from Fontenelle Reservoir on the Green River. The refuge was established in 1965 as a mitigation measure to replace wetland habitat removed during the development of Fontenelle Reservoir and Flaming Gorge. The refuge consists of natural and man-made wetlands that are being developed and managed to provide waterbird habitat. Waterfowl populations on the refuge peak during late migration and early nesting season with Canada goose, mallard, and green-winged teal as dominant species (FWS 1982). Other common waterfowl species include common merganser, gadwall, blue-winged teal, and pintail.

Many other species use the refuge besides waterfowl. The sandhill crane nests on the refuge, as do prairie falcon, merlin, and American kestrel. The wetlands are also used by mule deer, moose, raccoon, beaver, and red fox and gray fox. Upland game species include mourning dove, sage grouse, and cottontail. Three endangered species have been observed on the refuge. Bald eagles winter there; a high of 42 was counted in 1981-1982. One whooping crane has been observed during migration in 1981 and 1982. Peregrine falcons are observed regularly, about once or twice a year during migration. The refuge is a historical nesting site of peregrines and is considered potential nesting habitat. Other special status species using the refuge include migrating osprey and migrating great gray owl.

Another area of note is the Rock Creek drainage into LaBarge Creek just south of Exxon's Graphite Unit. It is presently classified by BLM as an Area of Critical Environmental Concern (ACEC) and is part of the Lake Mountain Wilderness Study Area (WSA). Because it is roadless, it constitutes valuable security cover for elk and other sensitive wildlife species. Rock Creek also supports a pure strain of the rare Colorado cutthroat trout.

WILDLIFE SPECIES AND HABITATS

Many species and wildlife habitats occur within the area potentially affected by the proposed and alternative actions. Identification and description of those determined to be significant helps to focus attention on those which are potentially most sensitive to adverse impact or are of most concern to state and federal agencies and the public. Significant wildlife and habitats are determined through discussions with wildlife biologists familiar with the area (Hinschberger 1982, Johnson 1982, Thornton 1982, Doughty 1982, Straley 1982, Gordon 1982, Weaver 1982, Oakleaf 1982, Lockman 1982, Row 1982, all personal communications) and through issues raised in public meetings and scoping (Riley Ridge Project-Public Concerns and Scope of Environmental Impact Statement).

Big Game

Most notable among issues identified is maintaining the abundance and diversity of big game ungulates. Five occur locally, these are elk, moose, mule deer, pronghorn, and bighorn sheep. These animals form the basis of a very important hunting and recreation industry supporting guest ranches and

motels, outfitters and guides, and sporting goods and other suppliers (see Recreation and Socioeconomic sections of the EIS).

Elk

Elk are an extremely important wildlife component in the Riley Ridge area. Higher elevations, primarily on FS and adjacent BLM lands, are valuable summer range. Within the well field, slightly lower elevations towards the east are used as parturition or calving grounds. Approximately 42,300 acres of WGF-classified critical¹ calving range occur within the well field (Map 1-1, see Map Pocket). This comprises 41 percent of the 102,400 acres of critical calving range within the Piney Elk Herd Unit. Areas lower and further east are used as wintering range. Approximately 32,370 acres within the well field are classified as critical winter range by WGF (Map 1-1, see Map Pocket). Winter range is probably the limiting factor for those elk populations that are dependent upon natural winter habitat off feedgrounds (Doughty, L. 1982, personal communication). This is 59 percent of the 55,000 acres of critical winter range within the Piney Elk Herd Unit (Mercier 1982, personal communication). The Riley Ridge well field occurs within that herd unit.

Many factors are involved in determining the importance of elk habitat to elk including vegetation types, amounts and arrangements of habitats, and degree of human disturbance. A method developed by the FS was used to evaluate existing elk habitat on FS and BLM lands on the study area. This method, "Estimating Effects of Habitat Changes on Potential Elk Use in Wyoming," was also used in evaluating the changes in elk habitat resulting from the proposed development of the Riley Ridge Project (Chapter 3). This procedure was originally developed in the Blue Mountains of Oregon and Washington, refined in the Bridger-Teton National Forest and elsewhere in the west, and was specifically designed for use in timber sale areas. Adaptation of these methods to oil and gas development has involved discussions with FS and BLM biologists (Hinschberger 1982, Doughty 1982, Gordon 1982, all personal communications). Results of this method are expressed as the percent elk habitat effectiveness of an area.

This habitat effectiveness percentage reflects the estimated use elk may make of an area, considering the amount (acreage) and arrangement of cover and forage (non-cover), the amount of human disturbance due to roads, and the availability of security cover for protection from human disturbance. An area with optimal cover and forage acreages and arrangements for a particular season, and no human disturbance, would have an elk habitat effectiveness of 100 percent. This methodology is a model that estimates elk use during spring-summer-fall (primarily summer-fall). Winter range use is underestimated with this methodology because the optimum cover percentage on winter ranges is lower than for summer ranges and access by humans and use by elk is greatly affected by snowfall. Roads closed by snow decrease human disturbance and allow elk use of protected areas to increase,

¹Note: Throughout this report references to critical range of game species refer to Wyoming Game and Fish Department's classification of important, limiting ranges. Critical habitat, as related to Federally classified threatened or endangered species with specific legal implications, does not occur in the study area.

while heavy snows may occasionally prevent elk from using portions of the winter range. Thus, evaluation of winter range using this methodology is misleading.

Percent elk habitat effectiveness was evaluated on habitat units designated by FS and BLM. The six units evaluated differed in habitat quality and importance to the local elk herd (Table 1-2). Habitat units on FS land are located in more heavily forested areas and are the best elk summer habitats in the well field and are valuable in some areas for calving and critical year-round range. Habitat units on the BLM land contain less cover, but are important because the long stringers (continuous strands) of cover along ridges allow elk access to forage and winter range to the east of the densely forested areas. Portions of BLM land are also used for calving (Map 1-1, see Map Pocket).

Cover is important to elk as a form of protection from predators and in its ability to decrease loss of body heat during severe winter weather. Hiding cover is vegetation that will screen 90 percent of an adult elk from a human's view at a distance of 200 feet or less (Thomas et al. 1979). A canopy closure over 40 percent generally provides sufficient cover for an elk. Heaviest elk use of cover patches occurs within 900 feet of the edge between cover and forage (FS 1981). To be used most effectively the cover patches should be 26 to 60 acres or arranged in long irregular stringers. Small areas do not provide enough protection for a herd, while larger areas have interior regions not used to the full potential (Reynolds 1966). However, these large patches of timber do provide areas for elk and other wildlife to hide and escape from hunters, while 60-acre patches of timber may not provide that cover.

Forage areas provide the grasses, forbs, and shrubs important in the elk diet. Preferred foods vary throughout the year and throughout elk range. Grass is most important in early spring and summer, though it may be eaten throughout the year (Boyd 1978). Forbs are most important in late summer and fall, and browse is the main food in winter when heavy snows cover the grasses and forbs. Forage species occur in all forest habitats, but are most valuable to elk in areas where the canopy closure is less than 40 percent (Thomas et al., 1979).

Studies in the Blue Mountains of Oregon suggest optimal elk summer habitat consists of 60 percent forage (non-cover) and 40 percent cover (Thomas et al. 1979). The Gros-Ventre Elk-Logging study found optimal elk spring-summer-fall habitat to be approximately 50/50 (Long et al. 1981). Habitat units on the Riley Ridge well field area have forage/cover ratios varying from 50/50 to 89/11 with an overall average of 64/36 (Table 1-2). Cover is considered to be a limiting factor affecting elk distribution on the spring-summer-fall range of the Riley Ridge well field area (Doughty 1982, personal communication). Any losses in cover may result in decreases in local elk populations.

Security cover is also an important component of elk habitat in areas subject to human disturbance (Peek et al. 1982). Security cover is an area used temporarily during periods of human disturbance in other nearby areas, including logging operations or hunting seasons. Optimal security cover consists of an area of individual cover patches, out of line of sight of human activity, inaccessible to motorized vehicles, and greater than

TABLE 1-2

PRESENT FORAGE/COVER RATIOS AND PERCENT ELK HABITAT EFFECTIVENESS OF
FORESTED LANDS ON THE RILEY RIDGE WELL FIELD STUDY AREA

	Total Acres	Forage/ Cover Ratio	% Habitat Effectiveness
<u>FS Land</u>			
Southern portion	11,018	67/33	45.4
Western portion	38,544	50/50	78.7
Eastern portion	<u>16,254</u>	51/49	46.8
All FS Land	65,816	53/47	65.2
<u>BLM Land</u>			
Southern portion	25,589	89/11	26.0
Central portion	24,568	67/33	6.0
Northern portion	<u>20,038</u>	68/32	4.8
All BLM Land	70,195	75/25	12.9
Well Field	136,011	64/36	38.2

¹Percent elk habitat effectiveness is the estimated use elk may make of an area, considering the amount and arrangement of cover and forage, the amount of human disturbance due to roads, and the availability of security cover.

5,000 acres in size. The area of security cover may not provide sufficient habitat to support large numbers of elk over a long period of time, but should be able to provide an area free from harassment for short periods of time for high densities of elk. Areas around Mount Darby and Fish Creek Mountain and to the west offer the best security cover to elk of the Riley Ridge area. Closing roads and prohibiting human access can also increase an area's security cover.

Roads can have an important effect on the value of elk habitat. Human disturbance is a serious threat to the stability of the elk herd in this area, and is directly related to road access. Studies of elk behavior near roads indicate that elk may avoid roads, particularly in areas with little or no cover (Lyon and Jensen 1980). Elk use may be less than optimum up to 0.9 mile from a road (Lyon 1979). Primitive roads with little traffic have less of an impact to elk than secondary roads with more traffic (Thomas et al. 1979). Over 86 percent of the existing elk habitat on the Riley Ridge area is within 0.9 mile of a road and thus subject to human disturbance and considered less than optimum elk habitat. Because of the lower amount of cover on BLM lands, this area is particularly sensitive to human disturbance, especially during winter months and during hunting seasons when elk may be at these lower elevations. The distribution of elk on BLM lands reflects the effect of roads on elk. Best populations of elk on these areas are where the least amount of improved gravel roads occur (Rock Creek/Graphite Hollow, Riley Ridge to Pine Grove, North Mountain, Finnegan Mountain).

The percent elk habitat effectiveness of an area includes an evaluation of all these effects. Present habitat effectiveness of elk habitat on the well field is 38.2 percent of potential (Table 1-2). This value reflects the combination of good elk summer habitat on FS land to the west, and lower quality summer habitat on BLM land in the eastern portion of the well field. This value also demonstrates the effect of roads within the area.

Elk habitat on the Riley Ridge well field area is of good quality and is critical to the existence of the herd in this area. Human disturbance and habitat loss are the most serious threats to the continued stability of the herd.

Habitat effectiveness for all FS land is 65.2 percent. The forage/cover ratio is 53/47; the high amount of cover contributes to the value of the area as good elk summer habitat. The FS land encompassing the proposed Darby Mountain Unit, western Lake Ridge Unit, and the western edge of the proposed North Riley Ridge Units (western portion, Table 1-2) had the highest percent habitat effectiveness: 78.7 percent. This area contains a high percentage of cover, has relatively few roads, and has access to security cover to the west. The eastern portion including Riley Ridge, Lake Ridge, and proposed North Riley Ridge Units, has more road access and is farther from security cover and thus has a lower habitat effectiveness. The southern portion including southern Lake Ridge Unit and western Fogarty Creek Unit, has more road access, less cover, and poor access to security cover compared to the other areas, giving it the lowest habitat effectiveness value of the FS land.

Elk habitat on the western portion of the well field in the FS land may at times have a habitat effectiveness of almost 100 percent, such as in winter and early spring when roads are closed by snow (but snow is not so deep as to preclude elk use), and human disturbance is minimal. This lack of human disturbance can be critical to maintaining calving areas (Hinschberger 1982, personal communication).

The BLM land exhibited much lower elk habitat effectiveness values, with an overall average of 12.9 percent. Forage/cover ratios average 75/25, contributing to the lower value as elk summer habitat. The area has little cover, poor access to security cover, and a high degree of road access from current development activities. The southern portion, including Graphite and Hogsback Units, has the highest habitat effectiveness, 26.0 percent, because it has fewer roads and better access to security cover. The central and northern portions; including eastern proposed North Riley Ridge, Riley Ridge, and Fogarty Creek, Dry Piney, and western Tip Top Units; have many roads and no access to security cover. BLM elk habitat is valuable to elk despite the habitat effectiveness values. It is good quality winter habitat with forested stringers that extend along the ridges, and public access restricted by private land owners at the base of Riley, Reed, and Trail Ridges.

Elk harvest in the Piney Elk Herd Unit was 583 animals in 1980 and 837 animals in 1981 (Table 1-3). Elk harvest in Hunt Area 94, which includes the well field, was 283 and 511 animals in 1980 and 1981, respectively. Harvest in Hunt Areas through which transportation corridors pass are also provided on Table 1-3.

Finnegan Feedground (an elk feedground operated by WGF) is located within the well field in the proposed North Riley Ridge Unit on Township 30N Range 114W Section 19. (Map 1-1, see Map Pocket.) Approximately 400 elk are fed there each winter (Johnson 1982, personal communication; Thornton 1982, personal communication), 389 were recorded there for 1981 (WGF 1982a). An additional 350 to 400 elk have been counted on other areas during winter aerial surveys by WGF resulting in estimates of 750 to 800 elk using the well field area each winter. Another 350 elk are fed at the North Piney Feedground, less than 2 miles from the northern end of the proposed gas field. About 2,230 elk occupy the Piney Elk Herd Unit (Mercier 1983, personal communication). A large critical wintering area also occurs south of the well field along transportation corridors to the south (Map 1-1, see Map Pocket); approximately 1,000 elk use that area each winter (Raper 1982, personal communication).

Mule Deer

Mule deer population levels in the area have varied considerably over the years (Straley 1982, personal communication). Deer within the Wyoming Range Herd demonstrate distinct seasonal preferences for habitat types and are extremely migratory, traveling 50 to 70 miles between winter and summer ranges. During the summer, deer utilize the higher elevations and at the onset of heavy snows move downward into the sagebrush areas where they demonstrate a strong affinity for south-facing slopes. This herd has been subject to periodic high winter losses ranging up to 50 percent mortality (WGF 1978). Recent population estimates indicate 8,000 to 10,000 mule deer winter in the area west of the Green River between Big Piney and LaBarge

TABLE 1-3

BIG GAME HARVEST INFORMATION FOR THE RILEY RIDGE PROJECT AREA

	1980	1981
<u>Elk</u>		
Piney Herd Unit (All Hunt Areas)	583	837
Hunt Area 94 - includes well field	283	511
Hunt Area 102 - corridors south (West Green River) ²	227	291
Hunt Area 98 - corridors southeast (Pinedale)	175	136
Hunt Area 101 - corridors southeast (Steamboat)	19	4
<u>Mule Deer</u>		
Wyoming Range Herd Unit (All Hunt Areas)	1	3,753
Hunt Area 143 - includes well field	788	767
Hunt Area 137 - corridors south	323	580
Hunt Area 138 - corridors southeast (Sublette)	0	5
Hunt Area 131 - corridors southeast (Steamboat)	214	126
<u>Moose</u>		
Sublette Herd Unit (All Hunt Areas)	304	349
Hunt Area 24 - on-Forest, well field	69	72
Hunt Area 25 - off-Forest, well field	114	133
Hunt Area 26 - corridors south (Lincoln)	138	143
<u>Pronghorn</u>		
Sublette Herd Unit (All Hunt Areas)	2,495	3,039
Hunt Area 89 - includes well field	467	526
Hunt Area 93 - corridors south (West Green River)	583	852
Hunt Area 90 - corridors southeast	175	174
Hunt Area 96 - corridors southeast	240	166
Hunt Area 92 - corridors southeast	144	151
<u>Black Bear</u>		
Sublette County	78	38
Hunt Area 14 - includes well field	25	6
Hunt Area 11 - corridors south	0	3
Hunt Area 12 - corridors southeast	0	0
Hunt Area 10 - corridors southeast	0	0
<u>Mountain Lion</u>		
Sublette County	0	NA
Hunt Area 17 - includes well field	NA	0
Hunt Area 14 - corridors south	NA	0
Hunt Area 11 - corridors southeast	NA	0

Source: Wyoming Game & Fish 1982; Wyoming Game & Fish 1981; Mercier 1982, personal communication

NA = Not Applicable. Wyoming Game & Fish Department does not report harvest for mountain lion by Hunt Area in 1980 or county in 1981.

¹The Wyoming Range Herd Unit was established in 1981.

²Names in parenthesis are Herd Units not included in well field.

(Johnson 1982, personal communication; Thornton 1982, personal communication). Current populations are relatively high, but down from peaks in the 1960s.

Mule deer occur throughout the well field area during the summer season and concentrate on the extreme eastern and southern portions of the well field and outside of well field boundaries during winter (Map 1-2, see Map Pocket). There are 7,500 acres of critical winter range occurring within the well field, about 2 percent of the 468,000 acres of critical winter range mapped within the Wyoming Range Mule Deer Herd Unit (Mercier 1982, personal communication). Most mule deer winter range in the Riley Ridge Project area occurs east of the well field in an area potentially affected by transportation corridors and gas treatment plants (Map 1-2, see Map Pocket).

Mule deer harvest in the Wyoming Range Herd Unit was 3,753 in 1981. Harvest in Hunt Area 143, which includes the well field, was 767 animals that year. Other harvest data are provided in Table 1-3.

Moose

Moose populations have been steadily increasing since the turn of the century. Current strong populations are reflected in the harvest statistics (Table 1-3). There were 349 kills in the Sublette Moose Herd in 1981. Hunt Area 24, on National Forest land, had 72 taken in 1981, and 133 were harvested in Hunt Area 25 outside the National Forest.

Moose use wooded habitats on the well field throughout the spring, summer, and fall and concentrate in the stream bottoms during winter periods (Map 1-3, see Map Pocket). Approximately 15,686 acres of critical winter/yearlong range are mapped for the well field, about 5 percent of the 312,000 acres designated as critical within the entire herd unit. Winter population estimates range from 400 to 500 west of the Green River between North Piney Creek and LaBarge Creek.

Pronghorn

Pronghorn (antelope) are abundant in the Riley Ridge area. Unwooded portions of the well field are used as summer range. Winter range occurs east of the well field in blocks on either side of the Green River (Map 1-4, see Map Pocket). No critical winter range occurs within the well field. Approximately 600 pronghorn winter between Big Piney and LaBarge west of the Green River, an additional 2,400 winter between Big Piney and LaBarge east of the river. The entire Riley Ridge Project area from Big Piney to Rock Springs to Kemmerer supports an estimated 20,000 pronghorn (Johnson 1982, personal communication; Thornton 1982, personal communication).

Bighorn Sheep

Bighorn sheep were re-introduced into the project area in 1981. Thirty-five sheep were transplanted onto Fish Creek Mountain in January of that year (Johnson 1982, personal communication). Both Fish Creek Mountain and Mount Darby are historical bighorn sheep range within the well field; bighorn sheep also occurred historically on five other mountain areas within the Wyoming Range (FS 1942). Since reintroduction the sheep have been doing well; 10 lambs were born to the group during 1981, and approximately 10 more

were born in 1982. Winter losses of adults have been few, while 3 of 10 lambs may have died during the winter of 1981-1982 (Johnson 1982, personal communication). Forty bighorn sheep were counted on and adjacent to Fish Creek Mountain in September 1982 in a survey conducted from horseback and on foot. More sheep were likely present but not observed, and biologists estimate approximately 50 bighorn sheep now occupy the Fish Creek Mountain Range (Map 1-4, see Map Pocket) (Johnson 1982, personal communication; Thornton 1982, personal communication). Hunting is not yet allowed on this bighorn population.

Black Bear and Mountain Lion

Black bear utilize a variety of habitats throughout the higher elevations within the well field area. Thirty-eight black bear were harvested in Sublette County during the 1981 season; six were harvested in Hunt Area 14 which includes the Riley Ridge well field (Table 1-3). Approximately 50 black bear are thought to inhabit the well field area (Johnson 1982, personal communication; Thornton 1982, personal communication). Mountain lions also occur but in far fewer numbers. There are consistent reports of lions in the Riley Ridge well field area, and they can be expected to be found associated with mule deer winter concentration areas. None were harvested in the Riley Ridge area in 1981 (Table 1-3). One lion was taken illegally during the 1982 big game season in the Riley Ridge well field area (Johnson 1982, personal communication).

Wild Horses

Wild horses occur over much of the project area, primarily out of the well field to the east and south. Approximately 470 horses occupy the five Wild Horse Management Areas located in the Riley Ridge project area.

Threatened and Endangered Species

Endangered species that have occurred or do occur in the project area include whooping crane, bald eagle, peregrine falcon, and black-footed ferret. No threatened species are known to occur.

Whooping cranes have been observed in the project area along the Green River, Fontenelle Creek, Meadow Canyon Creek, and South Piney Creek during the months of April, June, and September (WGF 1982b; Johnson 1982, personal communication) and on Seedskaadee National Wildlife Refuge during migration (FWS 1982).

Native seasonally flooded meadows, riparian habitats such as willows and wet meadows, and beaver ponds offer feeding and potential breeding habitat for cranes. Individuals using the study area are summering subadults from the Gray's Lake, Idaho flock. Breeding is not expected to be occurring because birds are young, but biologists hope for eventual breeding by these birds (Fitton 1982, personal communication). The region is considered important for whooping cranes because use is increasing, but no particular area has been identified as critical habitat.

Bald eagles concentrate along the Green River and also occur along its tributaries. Bald eagles generally occur in the region during October-May when most rivers and lakes are frozen (Map 1-5, see Map Pocket). At this time eagles concentrate on larger bodies of water, most notably the Green

River, Fontenelle Reservoir, and Seedskaadee National Wildlife Refuge, near open water where fish, the preferred food, may be caught. Since 1972, wintering bald eagle populations at Seedskaadee National Wildlife Refuge have been increasing (FWS 1980). The majority of the bald eagles observed on the project area occurred along the Green River below Fontenelle Reservoir, and about 5 miles south of Big Piney, Wyoming (WGF 1982b, BLM 1982). Cottonwoods along the river provide important roost sites where eagles concentrate during resting periods. Bald eagles have also been observed away from the river feeding on road kills, winter killed mule deer, and other carrion. Bald eagles have nested on the Green River in the past, and may potentially nest there in the future, particularly in habitat near Big Piney, and near the confluence of New Fork River and the Green River (Oakleaf 1982, personal communication).

The project area occurs within the breeding and migration range of the peregrine falcon. Peregrines have been observed during migration on the Seedskaadee National Wildlife Refuge on the Green River. Suitable nesting habitat, high cliffs near riparian habitat, occurs on the Bridger-Teton National Forest and adjacent lands, and on the National Wildlife Refuge. Peregrines rely on avian prey such as waterfowl, waterbirds, and songbirds. Raptor surveys will be conducted during spring 1983 to determine the presence of nesting raptors on the well field study area. Plant site and transportation corridor study areas were examined for raptor nesting during the prairie dog town surveys. No raptor nests were seen. It is unlikely that peregrines breed locally.

Sixteen confirmed and unconfirmed black-footed ferret sightings have been reported in the project area from 1968 to 1978; of these, 2 confirmed and 2 unconfirmed fall within the Riley Ridge study area (Clark 1980, Clark and Campbell 1981) as illustrated on Map 1-5 (see Map Pocket). No confirmed sightings have been reported in the area since 1978 nor have any ferret studies been conducted (Clark 1982, personal communication). Ferrets rely on prairie dogs for a source of food, thus are generally associated with prairie dog towns. A survey of prairie dog towns in the study area (well field, plant sites, and transportation corridor areas) was conducted in October 1982 to assist in determining the likelihood of black-footed ferret occurrence. Prairie dog towns mapped in that effort are presented on Map 1-5 (see Map Pocket). Prairie dog town surveys were not conducted along Utah Power and Light's or BLM's transmission line component alternatives.

The white-tailed prairie dog is an important species in this region because it is the major prey species of the federally listed endangered black-footed ferret. Because ferrets live in or near prairie dog towns, surveys for prairie dog towns indicate potential locations of black-footed ferrets. A summary of prairie dog towns and their sizes is provided in Table 1-4. (Town numbers refer to Map 1-5, see Map Pocket.)

White-tailed prairie dog activity was not observed within the well field, primarily because most of this area is above 7,500 feet elevation, and good prairie dog habitat does not occur. Prairie dogs typically occur on xeric (dry) sites with mixed stands of grasses and shrubs, usually below 8,500 feet elevation. Several inactive towns were observed near the eastern part of the field near the East and West Dry Basin plant sites. These potential colonies were small and probably would not provide a sufficient prey base to sustain ferrets over time.

TABLE 1-4

SUMMARY OF WHITE-TAILED PRAIRIE DOG COLONIES ASSOCIATED WITH PROJECT
COMPONENTS IN THE RILEY RIDGE STUDY AREA¹

Town No.	Acres	Town No.	Acres
1	44	46	368
2	194	47	371
3	88	48	126
4	209	49	22
5	53	50	158
6	98	51	339
7	46	52	348
8	120	53	369
9	119	54	107
10	75	55	30
11	39	56	481
12	37	57	58
13	157	58	264
14	245	59	20
15	147	60	267
16	15	61	33
17	135	62	44
18	155	63	30
19	350	64	30
20	328	65	68
21	41	66	23
22	20	67	85
23	10	68	1,005
24	54	69	65
25	177	70	46
26	46	71	143
27	431	72	1,310
28	149	73	56
29	124	74	127
30	204	75	79
31	287	76	55
32	292	77	166
33	61	78	126
34	99	79	40
35	221	80	107
36	30	81	47
37	53	82	253
38	371	83	149
39	30	84	122
40	90	85	150
41	31	86	64
42	26	87	20
43	87	88	89
44	283	89	143
45	75	90	551

TABLE 1-4 (CONTINUED)

Town No.	Acres	Town No.	Acres
91	35	139	701
92	112	140	171
93	84	141	184
94	302	142	751
95	254	143	34
96	207	144	88
97	64	145	44
98	306	146	36
99	243	147	78
100	174	148	99
101	242	149	74
102	146	150	567
103	553	151	30
104	56	152	126
105	11	153	329
106	27	154	86
107	63	155	71
108	632	156	58
109	256	157	48
110	97		
111	159	TOTAL	28,499
112	221		
113	112		
114	80		
115	32		
116	50		
117	54		
118	58		
119	30		
120	75		
121	22		
122	553		
123	540		
124	287		
125	804		
126	115		
127	1,146		
128	122		
129	161		
130	145		
131	522		
132	127		
133	66		
134	32		
135	618		
136	156		
137	109		
138	164		

¹ Distribution of prairie dog towns by project component is presented on Map 1-5, see Map Pocket.

Prairie dog towns are common east of the well field. One-hundred fifty-seven towns over 10 acres in size were mapped coinciding with corridors and on support facility areas with a total of approximately 28,500 acres of towns (Table 1-4). Many of these towns are large enough to support ferrets (i.e., 36 towns from 10 to 50 acres, 30 towns from 50 to 100 acres, 68 towns from 100 to 500 acres, 10 towns from 500 to 1,000 acres, 3 towns over 1,000 acres).

Prairie dog colonies in the study area are most common along rivers, streams, other drainages with wide valleys, and in disturbed areas where the soil is less compacted and grasses and forbs dominate the vegetation (e.g., along pipelines, hay fields, etc). Natural vegetation associated with towns included shrubs (e.g., Gardner saltbush, big sagebrush, hopsage, spiny sagebrush, shadscale, winterfat, horsebrush, rabbitbush) and grasses (e.g., squirreltail, Indian ricegrass, thick-spike wheatgrass). Prairie dogs are most common in areas dominated by short grasses and low shrubs, and are least common in dense stands of tall shrubs (i.e., sagebrush flats, greasewood) where visibility for predators is limited. They occasionally occur in areas with widely scattered tall sagebrush and greasewood. Prairie dog towns (potential black-footed ferret habitat) can occur within appropriate areas of sagebrush, greasewood, and mixed desert shrub habitats.

Several concentration areas were found along the corridors and support facility areas, including:

- R111W T29N - 8 colonies - several large colonies along the Green River east of Big Piney;
- R112W T26N - 10 colonies - just west of LaBarge;
- R112W T23N to R110W T20N - approximately 40 colonies - in the vicinity of the Shute Creek and Craven Creek plant sites;
- R108W T20N - 12 colonies - area east of Shute Creek plant site; and
- Areas west of Rock Springs, approximately 5 colonies.

(See Map 1-5, Map Pocket)

Prairie dogs are uncommon north and east of the Shute Creek plant site, and in the vicinity of the Buckhorn plant site, primarily because the region is dominated by dense sagebrush. They are also uncommon southwest of the Craven Creek plant site.

Small Game Mammals

Small game mammals occurring on the study area include desert cottontail, snowshoe hare, and red squirrel. Harvest statistics are presented in Table 1-5. Cottontails occur in a variety of habitats throughout the study area. The snowshoe hare and red squirrel occur in the higher elevations in conifer areas. In addition, the pygmy rabbit has recently been reported east of Kemmerer. This represents the first record of this species in Wyoming. It may occur in the Riley Ridge study area (Clark 1982, personal communication). Small mammals are not widely hunted and are generally harvested incidental to big game hunting.

TABLE 1-5

HARVEST STATISTICS FOR SMALL GAME, UPLAND GAME BIRDS, AND
WATERFOWL IN SUBLETTE COUNTY, 1980

Species	Number Harvested
Cottontail Rabbit	116
Snowshoe Hare	357
Sage Grouse	8,649
Blue Grouse	1,014
Ruffed Grouse	238
Chukar	10
Mourning Dove	110
Canada Goose	374
Ducks	1,887

Source: Wyoming Game and Fish Department 1981. Annual
Report of Upland Game and Furbearer Harvest 1980.

Upland Game Birds

Species occurring on the study area include sage grouse, blue grouse, ruffed grouse, chukar, and mourning dove. All are year-around residents except mourning dove; however, chukar are unusual. Harvest statistics for these species are also presented in Table 1-5. The sage grouse is the major upland game bird species on the study area. Sage grouse occur in sagebrush habitats, where they rely on sagebrush for food, escape cover, and nesting cover. Surveys will be conducted during spring 1983 to determine the number of sage grouse and active leks on the study area.

Blue grouse use a variety of habitat types throughout the year. During the summer blue grouse raise broods at lower elevations with shrubs and forbs providing food. Winter months are spent in heavy conifers at higher elevations. Ruffed grouse use habitats similar to the blue grouse; both species may occur in the Riley Ridge area, but the blue grouse is the most common. Aspen provide the major source of food and cover during most of the year. Conifers provide important cover during periods of heavy snow.

Chukar habitat consists primarily of mixed shrub and sagebrush on drier sites with more exposed vegetation. Grasses and seeds provide the major food source for adult birds, and insects are important for young chicks. Chukar are not common in the Riley Ridge area. The mourning dove is a summer resident, breeding in a variety of habitats. Doves prefer to nest in ecotones where they feed on a variety of seeds, and may be abundant near cultivated fields.

Waterbirds

Waterbirds include swans, geese, ducks, long-legged waders, shorebirds, cranes, coots, grebes, and loons. There are about 40 species of waterbirds common to the area, requiring wetland habitats for reproduction, feeding and resting.

Waterbirds utilize large water bodies such as Fontenelle Reservoir and Sixty-seven Reservoir for feeding and resting primarily. Shoreline mudflats provide feeding sites and loafing sites for shorebirds, ducks and geese. Small water bodies provide shallow water high in aquatic vegetation and invertebrate productivity.

The Green River is a migratory corridor for waterbirds produced in tributary drainages and wetlands throughout the upper basin. Seasonally flooded meadows on the Green River and tributary drainages provide the greatest quantity and quality of waterbird production habitat found in the area. The long-billed curlew is a unique species with affinity for this type.

Aquatic and wetland deciduous tree, deciduous shrub and emergent vegetation associated with beaver ponds are important to species such as the greater sandhill crane, dabbling ducks and cavity nesting species for breeding, reproduction, and brood-rearing.

Sandhill cranes have been observed on the study area along the Green River and tributary drainages including Middle and South Piney Creeks, Fontenelle Creek, Hams Fork, and Porcupine Creek. Grainfields, native wet meadows, riparian habitats and beaver ponds offer feeding and potential breeding habitat for cranes. Approximately 100 to 150 pairs breed in the Upper Green

River Management Area (Lockman 1982, personal communication). During 1979-1981, about 500 cranes staged between LaBarge and Pinedale (Lockman 1982, personal communication) and at least 500 were observed during September 1982 (Johnson 1982, personal communication). Large flocks of cranes observed in the fall may be local breeders or breeders from north of the study area where cranes breed in higher numbers (Row 1982, personal communication).

The Upper Green River basin is a very significant contributor to annual production for the Rocky Mountain greater sandhill crane population. Potential reproduction habitat for the whooping crane is coincidental with sandhill crane nesting distribution in the basin area. Fall staging cranes in the area are primarily adult breeders, young-of-the-year, and subadults from the upper basin and locally (Lockmann 1982, personal communication).

Other waterbirds typical of the area include long-billed curlew which nest along the Piney Creeks, and great blue heron which nest in heronries about 8 to 10 miles south of Big Piney on the Green River, New Fork River, and on the Seedsdakee National Wildlife Refuge. Large groups of white-faced ibis congregate at Fontenelle Reservoir during spring migration and no records of nesting exist for the area. Double-crested cormorants are numerous on the Green River; though breeding has not been documented for the area, some local individuals may possibly breed. Fontenelle Reservoir provides exposed mud flats important to foraging and resting shorebirds and waders.

Waterfowl habitat on the study area occurs along the major creeks, small reservoirs, beaver ponds, the Green River, Fontenelle Reservoir, and Seedsdakee National Wildlife Refuge. Nesting habitat is provided by the willows and grasses of riparian areas. Brood habitat and feeding habitat for Canada geese and puddle ducks occur along streams. Breeding densities of ducks reach as high as 17 pairs per square mile in some areas (Lockman 1982, personal communication). Fontenelle Reservoir offers feeding habitat for divers and resting habitat for large concentrations of migrants. Common species in the region include Canada goose, mallard, and blue-winged teal during the summer months. Breeding by common merganser, mallard, and green-winged teal occurs on Fontenelle Reservoir. Western and pied-billed grebes, common loon, whistling swan, and many species of ducks and geese occur in the area during migration or over winter. Harvest statistics are presented in Table 1-5.

Raptors

The Riley Ridge area has not been thoroughly surveyed for raptor species. Available information was gathered from federal and state agencies and local sources. Table 1-6 lists species whose distribution includes the study area. Additional studies are planned for spring 1983.

Six species were documented nesting on or near the study area, including golden eagle (18 nests), prairie falcon (6 nests), goshawk (1 nest), red-tailed hawk (23 nests), Swainson's hawk (1 nest), and ferruginous hawk (1 nest). Of the 50 known nests, 5 are located in the well field area: 1 prairie falcon nest, 1 goshawk nest, and 3 golden eagle nests. Nesting species observed are those preferring open habitats with nest sites in relatively visible locations.

TABLE 1-6

BIRDS POTENTIALLY OCCURRING ON THE RILEY RIDGE PROJECT AREA

Common Name	Scientific Name	Status ¹	Season ²	Abundance ³
Common Loon	<u>Gavia immer</u>	B	R	II
Arctic Loon	<u>Gavia arctica</u>	O	M	I
Horned Grebe	<u>Podiceps auritus</u>	O	M	II
Eared Grebe	<u>Podiceps nigricollis</u>	B	S	III
Western Grebe	<u>Aechmophorus occidentalis</u>	B	S	III
Pied-billed Grebe	<u>Podilymbus podiceps</u>	O	S	III
White Pelican	<u>Pelecanus erythrorhynchos</u>	O	S	III
Double-crested Cormorant	<u>Phalacrocorax auritus</u>	b	S	III
Great Blue Heron	<u>Ardea herodias</u>	B	S	III
Snowy Egret	<u>Egretta thula</u>	b	S	II
Green-backed Heron	<u>Butorides striatus</u>	O	S	II
Black-crowned Night Heron	<u>Nycticorax nycticorax</u>	B	S	II
American Bittern	<u>Botaurus lentiginosus</u>	O	S	VI
White-faced Ibis	<u>Plegadis chihi</u>	O	S	II
Whistling Swan	<u>Olor columbianus</u>	O	M	II
Canada Goose	<u>Branta canadensis</u>	B	R	IV
Snow Goose	<u>Chen caerulescens</u>	O	M	II
Mallard	<u>Anas platyrhynchos</u>	B	R	IV
Gadwall	<u>Anas strepera</u>	B	R	IV
Pintail	<u>Anas acuta</u>	B	R	IV
Green-winged Teal	<u>Anas crecca</u>	B	R	IV
Blue-winged Teal	<u>Anas discors</u>	B	S	III
Cinnamon Teal	<u>Anas cyanoptera</u>	B	S	III
American Wigeon	<u>Anas americana</u>	B	R	IV
Northern Shoveler	<u>Anas clypeata</u>	B	S	III
Redhead	<u>Aythya americana</u>	B	S	III
Ring-necked Duck	<u>Aythya collaris</u>	O	S	III
Canvasback	<u>Aythya valisineria</u>	B	S	II
Lesser Scaup	<u>Aythya affinis</u>	b	S	II
Common Goldeneye	<u>Bucephala clangula</u>	O	R	III
Barrow's Goldeneye	<u>Bucephala islandica</u>	O	R	III
Bufflehead	<u>Bucephala albeola</u>	O	R	II
Harlequin Duck	<u>Histrionicus histrionicus</u>	B	S	II
Ruddy Duck	<u>Oxyura jamaicensis</u>	B	S	III
Hooded Merganser	<u>Lophodytes cucullatus</u>	O	R	IV

TABLE 1-6 (CONTINUED)

Common Name	Scientific Name	Status ¹	Season ²	Abundance ³
Common Merganser	<u>Mergus merganser</u>	B	R	III
Red-breasted Merganser	<u>Mergus serrator</u>	O	S	II
Turkey Vulture	<u>Cathartes aura</u>	O	S	III
Goshawk	<u>Accipiter gentilis</u>	B	R	III
Sharp-shinned Hawk	<u>Accipiter striatus</u>	B	S	III
Cooper's Hawk	<u>Accipiter cooperii</u>	B	S	III
Red-tailed Hawk	<u>Buteo jamaicensis</u>	B	R	III
Swainson's Hawk	<u>Buteo swainsoni</u>	B	S	III
Rough-legged Hawk	<u>Buteo lagopus</u>	O	W	III
Ferruginous Hawk	<u>Buteo regalis</u>	B	R	III
Golden Eagle	<u>Aquila chrysaetos</u>	B	R	III
Bald Eagle	<u>Haliaeetus leucocephalus</u>	O	R	II
Marsh Hawk	<u>Circus cyaneus</u>	B	S	III
Osprey	<u>Pandion haliaetus</u>	b	S	III
Prairie Falcon	<u>Falco mexicanus</u>	B	R	III
Peregrine Falcon	<u>Falco peregrinus</u>	O	R	I
Merlin	<u>Falco columbarius</u>	B	R	II
American Kestrel	<u>Falco sparverius</u>	B	S	IV
Blue Grouse	<u>Dendragapus obscurus</u>	B	R	III
Ruffed Grouse	<u>Bonasa umbellus</u>	B	R	III
Sage Grouse	<u>Centrocercus urophasianus</u>	B	R	III
Chukar	<u>Alectoris chukar</u>	B	R	III
Gray Partridge	<u>Perdix perdix</u>	B	R	II
Whooping Crane	<u>Grus americana</u>	O	S	VII
Sandhill Crane	<u>Grus canadensis</u>	B	S	IV
Sora	<u>Porzana carolina</u>	B	S	III
American Coot	<u>Fulica americana</u>	B	S	IV
Semipalmated Plover	<u>Charadrius semipalmatus</u>	O	M	II
Killdeer	<u>Charadrius vociferus</u>	B	S	IV
Mountain Plover	<u>Charadrius montanus</u>	B	S	III
American Golden Plover	<u>Pluvialis dominica</u>	O	M	I
Black-bellied Plover	<u>Pluvialis squatarola</u>	O	M	II
Common Snipe	<u>Capella gallinago</u>	B	S	III
Long-billed Curlew	<u>Numenius americanus</u>	B	S	II
Spotted Sandpiper	<u>Actitis macularia</u>	b	S	III

TABLE 1-6 (CONTINUED)

Common Name	Scientific Name	Status ¹	Season ²	Abundance ³
Solitary Sandpiper	<u>Tringa solitaria</u>	0	M	III
Greater Yellowlegs	<u>Tringa melanoleuca</u>	0	M	III
Willet	<u>Catoptrophorus semipalmatus</u>	B	S	III
Baird's Sandpiper	<u>Calidris bairdii</u>	0	M	III
Least Sandpiper	<u>Calidris minutilla</u>	0	M	III
Samipalmed Sandpiper	<u>Calidris pusilla</u>	0	M	II
Long-billed Dowitcher	<u>Limnodromus scolopaceus</u>	0	M	III
Stilt Sandpiper	<u>Micropalama himantopus</u>	0	M	II
Marbled Godwit	<u>Limosa fedoa</u>	0	M	II
American Avocet	<u>Recurvirostra americana</u>	0	S	III
Black-necked Stilt	<u>Himantopus mexicanus</u>	0	S	II
Wilson's Phalarope	<u>Steganopus tricolor</u>	B	S	III
Northern Phalarope	<u>Lobipes lobatus</u>	0	M	II
Herring Gull	<u>Larus argentatus</u>	0	M	II
California Gull	<u>Larus californicus</u>	0	S	III
Ring-billed Gull	<u>Larus delawarensis</u>	0	S	III
Franklin's Gull	<u>Larus pipixcan</u>	0	S	III
Bonaparte's Gull	<u>Larus philadelphia</u>	0	M	II
Sabine's Gull	<u>Xema sabini</u>	0	M	I
Forster's Tern	<u>Sterna forsteri</u>	0	S	II
Common Tern	<u>Sterna hirundo</u>	0	S	II
Caspian Tern	<u>Sterna caspia</u>	0	S	II
Black Tern	<u>Chlidonias niger</u>	0	S	II
Rock Dove	<u>Columbia livia</u>	B	R	IV
Mourning Dove	<u>Zenaida macroura</u>	B	S	IV
Yellow-billed Cuckoo	<u>Coccyzus americanus</u>	0	S	II
Black-billed Cuckoo	<u>Coccyzus erythrophthalmus</u>	0	S	II
Barn Owl	<u>Tyto alba</u>	0	S	VI
Screech Owl	<u>Otus asio</u>	0	R	III
Great Horned Owl	<u>Bubo virginianus</u>	B	R	III
Pygmy Owl	<u>Glaucidium gnoma</u>	B	R	VI
Burrowing Owl	<u>Athene cunicularia</u>	B	S	II
Great Gray Owl	<u>Strix nebulosa</u>	0	R	VI
Long-eared Owl	<u>Asio otus</u>	B	R	III
Short-eared Owl	<u>Asio flammeus</u>	B	R	III

TABLE 1-6 (CONTINUED)

Common Name	Scientific Name	Status ¹	Season ²	Abundance ³
Saw-whet Owl	<u>Aegolius acadicus</u>	B	R	VI
Poor-will	<u>Phalaenoptilus nuttallii</u>	O	S	II
Common Nighthawk	<u>Chordeiles minor</u>	B	S	IV
White-throated Swift	<u>Aeronautes saxatalis</u>	O	S	III
Black-chinned Hummingbird	<u>Archilochus alexandri</u>	O	B	II
Broad-tailed Hummingbird	<u>Selasphorus platycercus</u>	B	S	III
Rufous Hummingbird	<u>Selasphorus rufus</u>	O	S	III
Calliope Hummingbird	<u>Stellula calliope</u>	O	S	III
Belted Kingfisher	<u>Megaceryle alcyon</u>	B	R	III
Common Flicker	<u>Colaptes auratus</u>	B	R	III
Red-headed Woodpecker	<u>Melanerpes erythrocephalus</u>	O	S	II
Lewis' Woodpecker	<u>Melanerpes lewis</u>	B	S	II
Yellow-bellied Sapsucker	<u>Sphyrapicus varius</u>	B	S	III
Williamson's Sapsucker	<u>Sphyrapicus thyroideus</u>	O	S	II
Hairy Woodpecker	<u>Picoides villosus</u>	B	R	II
Downy Woodpecker	<u>Picoides pubescens</u>	b	R	III
Northern Three-toed Woodpecker	<u>Picoides tridactylus</u>	B	R	II
Eastern Kingbird	<u>Tyrannus tyrannus</u>	O	S	III
Western Kingbird	<u>Tyrannus verticalis</u>	B	S	III
Ash-throated Flycatcher	<u>Myiarchus cinerascens</u>	O	S	VI
Say's Phoebe	<u>Sayornis saya</u>	B	S	III
Willow Flycatcher	<u>Empidonax traillii</u>	B	S	III
Least Flycatcher	<u>Empidonax minimus</u>	O	S	III
Hammond's Flycatcher	<u>Empidonax hammondi</u>	B	S	II
Dusky Flycatcher	<u>Empidonax oberholseri</u>	B	S	III
Gray Flycatcher	<u>Empidonax wrightii</u>	B	S	III
Western Flycatcher	<u>Empidonax difficilis</u>	B	S	III
Western Wood Pewee	<u>Contopus sordidulus</u>	B	S	III
Olive-sided Flycatcher	<u>Nuttallornis borealis</u>	B	S	III
Horned Lark	<u>Eremophila alpestris</u>	B	R	IV

TABLE 1-6 (CONTINUED)

Common Name	Scientific Name	Status ¹	Season ²	Abundance ³
Violet-green Swallow	<u>Tachycineta thalassina</u>	B	S	III
Tree Swallow	<u>Iridoprocne bicolor</u>	B	S	III
Bank Swallow	<u>Riparia riparia</u>	O	S	III
Rough-winged Swallow	<u>Stelgidopteryx ruficollis</u>	b	S	III
Barn Swallow	<u>Hirundo rustica</u>	B	S	III
Cliff Swallow	<u>Petrochelidon pyrrhonota</u>	B	S	III
Purple Martin	<u>Progne subis</u>	O	S	VI
Gray Jay	<u>Perisoreus canadensis</u>	B	R	III
Steller's Jay	<u>Cyanocitta stelleri</u>	B	R	III
Scrub Jay	<u>Aphelocoma coerulescens</u>	O	R	II
Black-billed Magpie	<u>Pica pica</u>	B	R	IV
Common Raven	<u>Corvus corax</u>	B	R	III
Common Crow	<u>Corvus brachyrhynchos</u>	O	R	III
Pinyon Jay	<u>Gymnorhinus cyanocephalus</u>	O	R	II
Clark's Nutcracker	<u>Nucifraga columbiana</u>	B	R	III
Black-capped Chickadee	<u>Parus atricapillus</u>	B	R	III
Mountain Chickadee	<u>Parus gambeli</u>	B	R	III
Plain Titmouse	<u>Parus inornatus</u>	b	R	II
Bushtit	<u>Psaltiriparus minimus</u>	O	S	VI
White-breasted Nuthatch	<u>Sitta carolinensis</u>	b	R	III
Red-breasted Nuthatch	<u>Sitta canadensis</u>	b	R	III
Pygmy Nuthatch	<u>Sitta pygmaea</u>	b	R	II
Brown Creeper	<u>Certhia familiaris</u>	O	R	III
Dipper	<u>Cinclus mexicanus</u>	B	R	III
House Wren	<u>Troglodytes aedon</u>	B	S	III
Bewick's Wren	<u>Thryomanes bewickii</u>	b	S	II
Long-billed Marsh Wren	<u>Cistothorus palustris</u>	B	S	III
Canyon Wren	<u>Catherpes mexicanus</u>	b	S	II
Rock Wren	<u>Salpinctes obsoletus</u>	B	S	III
Gray Catbird	<u>Dumetella carolinensis</u>	b	S	III
Sage Thrasher	<u>Oreoscoptes montanus</u>	B	S	III
American Robin	<u>Turdus migratorius</u>	B	R	IV
Hermit Thrush	<u>Catharus guttatus</u>	B	S	III
Swainson's Thrush	<u>Catharus ustulatus</u>	b	S	III
Veery	<u>Catharus fuscescens</u>	B	S	II

TABLE 1-6 (CONTINUED)

Common Name	Scientific Name	Status ¹	Season ²	Abundance ³
Western Bluebird	<u>Sialia mexicana</u>	0	S	II
Mountain Bluebird	<u>Sialia currucoides</u>	B	S	III
Townsend's Solitaire	<u>Myadestes townsendi</u>	0	R	III
Blue-gray Gnatcatcher	<u>Polioptila caerulea</u>	0	S	II
Golden-crowned Kinglet	<u>Regulus satrapa</u>	B	R	II
Ruby-crowned Kinglet	<u>Regulus calendula</u>	B	S	III
Water Pipit	<u>Anthus spinoletta</u>	0	S	IV
Sprague's Pipit	<u>Anthus spragueii</u>	0	M	II
Bohemian Waxwing	<u>Bombycilla garrulus</u>	0	W	III
Cedar Waxwing	<u>Bombycilla cedrorum</u>	0	R	II
Northern Shrike	<u>Lanius excubitor</u>	0	W	III
Loggerhead Shrike	<u>Lanius ludovicianus</u>	B	S	III
Starling	<u>Sturnus vulgaris</u>	B	R	IV
Solitary Vireo	<u>Vireo solitarius</u>	0	S	II
Red-eyed Vireo	<u>Vireo olivaceus</u>	0	S	II
Warbling Vireo	<u>Vireo gilvus</u>	B	S	IV
Tennessee Warbler	<u>Vermivora peregrina</u>	0	M	II
Orange-crowned Warbler	<u>Vermivora celata</u>	B	S	II
Nashville Warbler	<u>Vermivora ruficapilla</u>	0	M	I
Virginia's Warbler	<u>Vermivora virginiae</u>	0	S	VI
Northern Parula	<u>Parula americana</u>	0	M	I
Yellow Warbler	<u>Dendroica petechia</u>	B	S	IV
Yellow-rumped Warbler	<u>Dendroica coronata</u>	B	S	III
Black-throated Gray Warbler	<u>Dendroica nigrescens</u>	b	S	II
Townsend's Warbler	<u>Dendroica townsendi</u>	0	S	VI
Ovenbird	<u>Seiurus aurocapillus</u>	0	S	III
Northern Waterthrush	<u>Seiurus noveboracensis</u>	0	M	II
MacGillivray's Warbler	<u>Oporornis tolmiei</u>	B	S	III
Common Yellowthroat	<u>Geothlypis trichas</u>	B	S	III
Yellow-breasted Chat	<u>Icteria virens</u>	b	S	III
Wilson's Warbler	<u>Wilsonia pusilla</u>	B	S	III
American Redstart	<u>Setophaga ruticilla</u>	b	S	II
House Sparrow	<u>Passer domesticus</u>	B	R	IV
Bobolink	<u>Dolichonyx oryzivorus</u>	b	R	II
Western Meadowlark	<u>Sturnella neglecta</u>	B	S	IV
Yellow-headed Blackbird	<u>Xanthocephalus xanthocephalus</u>	B	S	III
Red-winged Blackbird	<u>Agelaius phoeniceus</u>	B	S	IV
Northern Oriole	<u>Icterus galbula</u>	B	S	III
Brewer's Blackbird	<u>Euphagus cyanocephalus</u>	B	S	IV

TABLE 1-6 (CONTINUED)

Common Name	Scientific Name	Status ¹	Season ²	Abundance ³
Common Grackle	<u>Quiscalus quiscula</u>	B	S	III
Brown-headed Cowbird	<u>Molothrus ater</u>	B	S	III
Western Tanager	<u>Piranga ludoviciana</u>	B	S	III
Rose-breasted Grosbeak	<u>Pheucticus ludovicianus</u>	O	M	II
Black-headed Grosbeak	<u>Pheucticus melanocephalus</u>	B	S	III
Lazuli Bunting	<u>Passerina amoena</u>	b	S	III
Evening Grosbeak	<u>Hesperiphona vespertina</u>	B	R	III
Purple Finch	<u>Carpodacus purpureus</u>	O	W	II
Cassin's Finch	<u>Carpodacus cassinii</u>	b	R	III
House Finch	<u>Carpodacus mexicanus</u>	b	R	III
Pine Grosbeak	<u>Pinicola enucleator</u>	b	R	II
Gray-crowned Rosy Finch	<u>Leucosticte tephrocotis</u>	O	R	III
Black Rosy Finch	<u>Leucosticte atrata</u>	b	R	II
Brown-capped Rosy Finch	<u>Leucosticte australis</u>	O	R	V
Common Redpoll	<u>Carduelis flammea</u>	O	W	II
Pine Siskin	<u>Carduelis pinus</u>	B	R	III
American Goldfinch	<u>Carduelis tristis</u>	b	R	III
Lesser Goldfinch	<u>Carduelis psaltria</u>	O	M	II
Red Crossbill	<u>Loxia curvirostra</u>	B	R	III
White-winged Crossbill	<u>Loxia leucoptera</u>	O	W	II
Green-tailed Towhee	<u>Pipilo chlorurus</u>	B	S	III
Rufous-sided Towhee	<u>Pipilo erythrophthalmus</u>	O	S	III
Lark Bunting	<u>Calamospiza melanocorys</u>	B	S	IV
Savannah Sparrow	<u>Passerculus sandwichensis</u>	O	S	III
Grasshopper Sparrow	<u>Ammodramus savannarum</u>	b	S	III
Vesper Sparrow	<u>Pooecetes gramineus</u>	B	S	III
Lark Sparrow	<u>Chondestes grammacus</u>	b	S	III
Black-throated Sparrow	<u>Amphispiza bilineata</u>	O	S	VI
Sage Sparrow	<u>Amphispiza belli</u>	B	S	III
Dark-eyed Junco	<u>Junco hyemalis</u>	B	R	III
Gray-headed Junco	<u>Junco caniceps</u>	b	R	III
Tree Sparrow	<u>Spizella arborea</u>	O	W	II
Chipping Sparrow	<u>Spizella passerina</u>	B	S	III
Brewer's Sparrow	<u>Spizella breweri</u>	B	S	III
White-crowned Sparrow	<u>Zonotrichia leucophrys</u>	B	S	III

TABLE 1-6 (CONTINUED)

Common Name	Scientific Name	Status ¹	Season ²	Abundance ³
White-throated Sparrow	<u>Zonotrichia albicollis</u>	0	M	II
Fox Sparrow	<u>Passerella iliaca</u>	B	R	III
Lincoln's Sparrow	<u>Melospiza lincolni</u>	b	S	III
Song Sparrow	<u>Melospiza melodia</u>	0	R	III
McCown's Longspur	<u>Calcarius mccownii</u>	0	S	III
Snow Bunting	<u>Plectrophenax nivalis</u>	0	W	II

Source: Oakleaf, B., H. Downing, B. Raynes, M. Raynes, and O. K. Scott.
1982. Wyoming Avian Atlas. Wyoming Game and Fish Department and
Bighorn Audubon Society.

¹Status - B = Breeding confirmed
b = Breeding suspected
0 = Observed

²Season - R = Inhabits Wyoming yearround
S = Summer resident
M = Migrant
W = Wintering species

³Abundance (in Wyoming) I = Rare
II = Uncommon
III = Common
IV = Abundant
V = Peripheral
VI = Undetermined
VII = Controlled

Most of the raptors expected to occur on the study area are species preferring open habitats. Red-tailed hawk, ferruginous hawk, and golden eagle nest in trees or on rock ledges in open habitats, while Swainson's hawk usually prefers tree nest sites. Prairie falcon nests occur on isolated rock ledges. Goshawk, Cooper's hawk, and sharp-shinned hawk nest in more dense forest situations and prey on birds more than other raptors do, whereas merlin nest in open forest areas. American kestrel nest in tree cavities or on rock ledges. Marsh hawk is an exclusive ground nester and forages for small mammals in grasslands and marshes. Turkey vultures forage throughout the area for carrion but do not nest in the study area. Osprey nest in trees along water courses where they feed exclusively on fish. Breeding has not been documented for the study area but may potentially occur along the Green River. Rough-legged hawks usually winter in the vicinity, hunting for jackrabbits and small mammals in open country.

Eight species of owls potentially occur in the area. Long-eared, flammulated, saw-whet, and pygmy owls all nest in dense forest situations. Great-horned and screech owls use a variety of habitats including forest and forest-grassland ecotones. A great-horned owl nest is located in the well field. Short-eared owls nest in open grasslands and hunt small mammals over plains and marshes. Burrowing owls occur on the plains, nesting in prairie dog holes and feeding on insects and small mammals.

Other Non-Game Wildlife

A variety of other non-game wildlife inhabit the Riley Ridge project area. A list of birds is found on Table 1-6, mammals on 1-7, and reptiles and amphibians on 1-8. Habitat associations for all species are presented on Table 1-9.

Many species of songbirds potentially occur in the area. Quantitative avian surveys were not conducted for EIS preparation, but breeding bird surveys were conducted in 1980, 1981, and 1982 by WGF biologists along the western edge of the study area. Common species observed in those surveys included black-capped chickadee, American robin, mountain bluebird, and chipping sparrow.

Non-game mammals in the area potentially include five species of shrews and nine species of bats. Pikas occur in talus slopes at higher elevations, and white-tailed jackrabbit is common in open habitats. The rodents are by far the most numerous mammals and include a variety of chipmunks, ground squirrels, pocket gophers, mice, and voles. A small mammal trapping survey was conducted in 1981 by the FS on the North Horse Creek Aspen Rejuvenation Area north of the Riley Ridge well field. The most common species trapped were the deer mouse, yellow-pine chipmunk, southern red-backed vole, and Uinta ground squirrel. Porcupines are a part of the forest and riparian ecosystems. Beaver, coyote, red fox, raccoon, bobcat, and several of the mustelid, or members of the weasel family, are trapped for fur in the area. Badger diggings were commonly observed in well field habitats.

Amphibians and reptiles are part of Riley Ridge Project area ecosystems. Twelve species are expected to occur. The amphibians rely upon various aquatic habitats, particularly at the lower elevations. Wetland areas and temporary ponds are important; streams and ponds are also used. Reptiles are less dependent on aquatic habitats, but certain species such as the

TABLE 1-7

MAMMALS EXPECTED TO OCCUR ON THE RILEY RIDGE PROJECT AREA

Common Name	Scientific Name
INSECTIVORES	
Family Soricidae - Shrews	
Masked Shrew	<u>Sorex cinereus</u>
Vagrant Shrew	<u>Sorex vagrans</u>
Dusky Shrew	<u>Sorex monticolus</u>
Water Shrew	<u>Sorex palustris</u>
Merriam's Shrew	<u>Sorex merriami</u>
BATS	
Family Vespertilionidae - Vespertilionid Bats	
Little Brown Myotis	<u>Myotis lucifugus</u>
Long-eared Myotis	<u>Myotis evotis</u>
Long-legged Myotis	<u>Myotis volans</u>
Small-footed Myotis	<u>Myotis leibii</u>
Silver-haired Bat	<u>Lasionycteris noctivagans</u>
Big Brown Bat	<u>Eptesicus fuscus</u>
Hoary Bat	<u>Lasiurus cinereus</u>
Spotted Bat	<u>Euderma maculatum</u>
Townsend's Big-eared Bat	<u>Plecotus townsendii</u>
LAGOMORPHS	
Family Ochotonidae - Pikas	
Pika	<u>Ochotona princeps</u>
Family Leporidae - Hares and Rabbits	
Nuttall's Cottontail	<u>Sylvilagus nuttalli</u>
Desert Cottontail	<u>Sylvilagus audubonii</u>
Snowshoe Hare	<u>Lepus americanus</u>
White-tailed Jack Rabbit	<u>Lepus townsendii</u>
RODENTS	
Family Sciuridae - Squirrels	
Least Chipmunk	<u>Eutamias minimus</u>
Yellow-pine Chipmunk	<u>Eutamias amoenus</u>
Uinta Chipmunk	<u>Eutamias umbrinus</u>
Yellow-bellied Marmot	<u>Marmota flaviventris</u>
Richardson's Ground Squirrel	<u>Spermophilus richardsonii</u>
Uinta Ground Squirrel	<u>Spermophilus armatus</u>
Golden-mantled Ground Squirrel	<u>Spermophilus lateralis</u>
White-tailed Prairie Dog	<u>Cynomys leucurus</u>

TABLE 1-7 (CONTINUED)

Common Name	Scientific Name
RODENTS (Con't.)	
Red Squirrel	<u>Tamiasciurus hudsonicus</u>
Northern Flying Squirrel	<u>Glaucomys sabrinus</u>
Family Geomyidae - Pocket Gophers	
Northern Pocket Gopher	<u>Thomomys talpoides</u>
Idaho Pocket Gopher	<u>Thomomys idahoensis</u>
Family Heteromyidae - Heteromyids	
Olive-backed Pocket Mouse	<u>Perognathus fasciatus</u>
Great Basin Pocket Mouse	<u>Perognathus parvus</u>
Ord's Kangaroo Rat	<u>Dipodomys ordii</u>
Family Castoridae - Beavers	
Beaver	<u>Castor canadensis</u>
Family Cricetidae - New World Rats and Mice	
Deer Mouse	<u>Peromyscus maniculatus</u>
Northern Grasshopper Mouse	<u>Onychomys leucogaster</u>
Bushy-tailed Woodrat	<u>Neotoma cinerea</u>
Southern Red-backed Vole	<u>Clethrionomys gapperi</u>
Heather Vole	<u>Phenacomys intermedius</u>
Meadow Vole	<u>Microtus pennsylvanicus</u>
Montane Vole	<u>Microtus montanus</u>
Long-tailed Vole	<u>Microtus longicaudus</u>
Water Vole	<u>Arvicola richardsoni</u>
Sagebrush Vole	<u>Lagurus curtatus</u>
Muskrat	<u>Ondatra zibethicus</u>
Family Zapodidae - Jumping Mice	
Western Jumping Mouse	<u>Zapus princeps</u>
Family Erethizontidae - New World Porcupines	
Porcupine	<u>Erethizon dorsatum</u>
CARNIVORES	
Family Canidae - Canids	
Coyote	<u>Canis latrans</u>
Red Fox	<u>Vulpes vulpes</u>
Family Ursidae - Bears	
Black Bear	<u>Ursus americanus</u>
Family Procyonidae - Procyonids	
Raccoon	<u>Procyon lotor</u>

TABLE 1-7 (CONTINUED)

Common Name	Scientific Name
CARNIVORES	
Family Mustelidae - Mustelids	
Marten	<u>Martes americana</u>
Fisher	<u>Martes pennanti</u>
Ermine	<u>Mustela erminea</u>
Long-tailed Weasel	<u>Mustela frenata</u>
Black-footed Ferret	<u>Mustela nigripes</u>
Mink	<u>Mustela vison</u>
Wolverine	<u>Gulo gulo</u>
Badger	<u>Taxidea taxus</u>
Striped Skunk	<u>Mephitis mephitis</u>
River Otter	<u>Lutra canadensis</u>
Family Felidae - Cats	
Mountain Lion	<u>Felis concolor</u>
Lynx	<u>Felis lynx</u>
Bobcat	<u>Felis rufus</u>
EVEN-TOED UNGULATES	
Family Cervidae - Cervids	
Wapiti or Elk	<u>Cervus elaphus</u>
Mule Deer	<u>Odocoileus hemionus</u>
White-tailed Deer	<u>Odocoileus virginianus</u>
Moose	<u>Alces alces</u>
Family Antilocapridae - Pronghorn	
Pronghorn	<u>Antilocapra americana</u>
Family Bovidae - Bovids	
Mountain Sheep	<u>Ovis canadensis</u>

TABLE 1-8

AMPHIBIANS AND REPTILES EXPECTED TO OCCUR ON THE RILEY RIDGE PROJECT AREA

Common Name	Scientific Name
CAUDATA - SALAMANDERS	
AMBYSTOMA - MOLE SALAMANDERS Blotched Tiger Salamander	<u>Ambystoma tigrinum melanostictum</u>
SALIENTIA - FROGS AND TOADS	
BUFO - TOADS Boreal Toad	<u>Bufo boreas boreas</u>
PSEUDACRIS - CHORUS FROGS Boreal Chorus Frog	<u>Pseudacris triseriata maculata</u>
RANA - TRUE FROGS Northern Leopard Frog Spotted Frog	<u>Rana pipiens</u> <u>Rana pretiosa</u>
SCAPHIOPUS - SPADEFOOT TOADS Great Basin Spadefoot	<u>Scaphiopus intermountanus</u>
SAURIA - LIZARDS	
PHRYNOSOMA - HORNED LIZARDS Short-horned Lizard	<u>Phrynosoma douglassi</u>
SCELOPORUS - SPINY LIZARDS Northern Sagebrush Lizard	<u>Sceloporus graciosus graciosus</u>
SERPENTES - SNAKES	
CHARINA - RUBBER BOAS Rubber Boa	<u>Charina bottae</u>
COLUBER - RACERS Western Yellowbelly Racer	<u>Coluber constrictor mormon</u>
PITUOPHIS - BULLSNAKES, PINE SNAKES AND GOPHER SNAKES Great Basin Gopher Snake	<u>Pituophis melanoleucus deserticola</u>
THAMNOPHIS - GARTER SNAKES AND RIBBON SNAKES Wandering Garter Snake	<u>Thamnophis elegans vagrans</u>

TABLE 1-9

HABITAT ASSOCIATIONS FOR WILDLIFE SPECIES POTENTIALLY OCCURRING ON RILEY RIDGE PROJECT AREA
(MAMMALS)

SPECIES	Wildlife Habitat Type						Mixed Desert Shrub	Pasture/ Hayfield	Riparian	Aquatic	Barren/ Disturbed
	Conifer	Clearcut	Aspen	Sagebrush	Mountain Shrub	Bunchgrass /Forb	Greasewood	Saltbush			
Masked Shrew	B	B	B	B	B				B		
Vagrant Shrew	B	B	B	B	B				B		
Dusky Shrew	B	B	B	B	B				B		
Water Shrew	B ¹	B ¹	B ¹						B	F	
Merriam's Shrew				B					B		
Little Brown Myotis	B	F	F	F	F		F	F	B	F	F
Long-eared Myotis	B	F	F	F	F				B	F	F
Long-legged Myotis	B-	F	F	B		B	F	F	B	F	F
Small-footed Myotis											
Silver-haired Bat	B	F	F						F	F	
Big Brown Bat	B		F	F	F		F	F	F	F	F
Hoary Bat	B		F	F	F		F	F	F	F	
Spotted Bat			B	B	B		F	F	F	F	
Townsend's Big-eared Bat			F	B	F		F	F	B		F
Pika						B					B
Nuttall's Cottontail			B	B	B				B		
Desert Cottontail				B			B	B	B		
Snowshoe Hare	B	B	B	B	B		B	B	B		
White-tailed Jack Rabbit			B	B	B		B	B	B		
Least Chipmunk											
Yellow-pine Chipmunk	B		B	B	B				B		
Uta Chipmunk	B		B	B	B	B			B		
Yellow-bellied Marmot	B		B	B	B				B		B
Richardson's Ground Squirrel				B	B		B	B	B		
Uta Ground Squirrel	B	B	B	B	B				B		
Golden-mantled Ground Squirrel	B		B	F	B		B	B	F		B
White-tailed Prairie Dog				B							
Red Squirrel	B		B								
Northern Flying Squirrel	B		B								
Northern Pocket Gopher	B	B	B	B	B				B		
Idaho Pocket Gopher	B	B	B								
Olive-backed Pocket Mouse				B			B	B			
Great Basin Pocket Mouse				B			B	B			
Ord's Kangaroo Rat				B			B				
Beaver	F ¹		F ¹						B	B	
Deer Mouse	B	B	B	B	B		B	B	B		B
Northern Grasshopper Mouse				B	B		B	B			
Bushy-tailed Woodrat	B		B	B	B		B	B	B		B
Southern Red-backed Vole	B		B						B		
Heather Vole	B		B			B			B		

TABLE 1-9 (CONTINUED)

SPECIES	Wildlife Habitat Type										Mixed Desert Shrub	Pasture/ Hayfield	Riparian	Aquatic	Barren/ Disturbed
	Conifer	Clearcut	Aspen	Sagebrush	Mountain		Bunchgrass /Forb	Greasewood	Saltbush						
					Shrub	Shrub									
Meadow Vole	B		B	B			B						B		
Montane Vole	B		B	B		B	B						B		
Long-tailed Vole	B		B	B		B	B						B		
Water Vole					F		F							F	
Sagebrush Vole				B			B	B	B		B				
Muskrat														B	
Western Jumping Mouse						B							B		
Porcupine		F	B			B							B		
Coyote	B	B	B	B		B	B	B	B		B		B		F
Red Fox	B		B	B		B							B		
Black Bear	B	B	B	F	F		F						B		R
Raccoon	B												B		
Marten	B		F										B		
Fisher	B		F										B		
Ermine	B		B		B								B		B
Long-tailed Weasel															
Black-footed Ferret	B		B	B		B		B	B		B		B		B
Mink				B											
Wolverine	B		B	B	B		B	B	B		B		B		B
Badger															
Striped Skunk				B				B	B		B		B		
River Otter															
Mountain Lion															
Lynx	B	F	B	B	B		F						B		R
Bobcat	B	F	B	B	B		F	B	B		B		B		R
Wapiti or Elk	B	F	B	B		F	F						B		B
Mule Deer	B	F	B	B	B		F	F	F		F		B		R
Moose	B	F	B	F	F		F	F	F		F		B		R
Pronghorn			F	B	F		F	F	F		B		F		B
Mountain Sheep	R				B		B	F	B						B

¹Associated with aquatic or riparian situations in these habitats.

R = Reproduction

F = Foraging

B = Both

TABLE 1-9

HABITAT ASSOCIATIONS FOR WILDLIFE SPECIES POTENTIALLY OCCURRING ON RILEY RIDGE PROJECT AREA
(BIRDS)

SPECIES	Wildlife Habitat Type							Mixed Desert Shrub	Pasture Hayfield	Riparian	Aquatic	Barren/ Disturbed
	Conifer	Clearcut	Aspen	Sagebrush	Mountain Shrub	Bunchgrass /Forb	Greasewood	Saltbush				
Common Loon										B	B	
Arctic Loon										F	F	
Horned Grebe										F	F	
Eared Grebe										B	B	
Western Grebe										B	B	
Pied-billed Grebe										B	B	
White Pelican											F	
Double-crested Cormorant										B	B	
Great Blue Heron								F		B	F	
Snowy Egret										B	B	
Green-backed Heron										B	B	
Black-crowned Night Heron										B	B	
American Bittern										B	B	
White-faced Ibis								F		B	B	
Whistling Swan											F	
Trumpeter Swan										B	B	
Canada Goose									F	B	B	
Snow Goose									F	F	F	
Mallard				R			R	R	B	B	B	
Gadwall										B	B	
Pintail												
Green-winged Teal				R					B	B	B	
Blue-winged Teal									B	B	B	
Cinnamon Teal									B	B	B	
American Wigeon				R			R	R	B	B	B	
Northern Shoveler									B	B	B	
Redhead									B	B		
Ring-necked Duck							R	R	F	F		
Canvasback									B	B		
Lesser Scaup									B	B		
Common Goldeneye	F1		F1							F	F	
Barrow's Goldeneye	F1		F1							F	F	
Bufflehead	F1		F1							F	F	
Harlequin Duck										B	B	
Ruddy Duck										B	B	
Hooded Merganser										F	F	
Common Merganser										B	B	
Red-breasted Merganser												
Turkey Vulture	B	F		F	F	F	F	F	F	F	F	F
Goshawk												

TABLE 1-9 (CONTINUED)

SPECIES	Wildlife Habitat Type										Mixed Desert Shrub	Pasture Hayfield	Riparian	Aquatic	Barren/ Disturbed
	Conifer	Clearcut	Aspen	Sagebrush	Mountain		Bunchgrass /Forb	Greasewood	Saltbush						
					Shrub	Shrub									
Sharp-shinned Hawk	B	F	B	F	F	F	F						F		
Cooper's Hawk	B	F	B	F	F	F	F						F		
Red-tailed Hawk	B	F	B	F	F	F	F	F	F	F			B	F	B
Swainson's Hawk		F	B	B	B	F	B	B	B	B			B		F
Rough-legged Hawk				F			F	F	F	F			F		
Ferruginous Hawk				B			B	B	F	F			F		R
Golden Eagle	B	F	F	F	F	F	F	F	F	F			F	F	B
Bald Eagle				F	F	F	F	F	F	F			F	F	F
Marsh Hawk			F	B	B	B	B	B	B	B			B	B	F
Osprey	R ¹													R	
Prairie Falcon				F			B	F	F	F			F	F	R
Peregrine Falcon		F	F	F	F	F	F	F	F	F			F	F	B
Merlin			F	F	F	F	F	F	F	F			F	B	
American Kestrel	B	F	B	F	F	F	F	F	F	F				B	B
Blue Grouse	B	F	B	B	B	B	F								
Ruffed Grouse															
Sage Grouse		F	B	B	B	B		B	B	B			B	F	
Chukar				B	B	B	F						B	B	
Gray Partridge					B								B	F	
Whooping Crane															
Sandhill Crane													B	B	
Sora			F												
American Coot															
Semipalmated Plover				B				B		B				B	B
Killdeer													B	F	F
Mountain Plover				F			F								
American Golden Plover													F	F	
Black-bellied Plover													F	F	
Common Snipe													B	B	B
Long-billed Curlew				B									B	F	F
Spotted Sandpiper													B	B	B
Solitary Sandpiper													F	F	F
Greater Yellowlegs													B	F	F
Willet														B	F
Baird's Sandpiper														F	F
Least Sandpiper														F	F
Semipalmated Sandpiper														F	F
Long-billed Dowitcher														F	F
Stilt Sandpiper														F	F
Marbled Godwit														F	F

TABLE 1-9 (CONTINUED)

SPECIES	Wildlife Habitat Type										Aquatic	Barren/ Disturbed
	Conifer	Clearcut	Aspen	Mountain			Greasewood	Bunchgrass		Mixed Desert	Pasture	Riparian
				Sagebrush	Shrub	Shrub		/Forb	Saltbush			
American Avocet											F	F
Black-necked Stilt											F	F
Wilson's Phalarope											B	B
Northern Phalarope											F	F
Herring Gull											F	F
California Gull				F							F	F
Ring-billed Gull				F							F	F
Franklin's Gull				F							F	F
Bonaparte's Gull											F	F
Sabine's Gull											F	F
Forster's Tern											F	F
Common Tern											F	F
Caspian Tern											F	F
Black Tern											F	F
Rock Dove				R							B	B
Mourning Dove											F	F
Yellow-billed Cuckoo											F	F
Black-billed Cuckoo											F	F
Barn Owl											F	F
Screech Owl											B	B
Great Horned Owl											F	F
Pygmy Owl											B	B
Burrowing Owl											B	B
Great Gray Owl											F	F
Long-eared Owl											F	F
Short-eared Owl											B	B
Saw-whet Owl											B	B
Poor-will											F	F
Common Nighthawk											F	F
White-throated Swift											B	B
Black-chinned Hummingbird											F	F
Broad-tailed Hummingbird											F	F
Rufous Hummingbird											F	F
Calliope Hummingbird											F	F
Belted Kingfisher											B	B
Common Flicker											F	F
Red-headed Woodpecker											F	F
Lewis' Woodpecker											F	F
Yellow-bellied Sapsucker											B	B
Williamson's Sapsucker											B	B

TABLE 1-9 (CONTINUED)

SPECIES	Wildlife Habitat Type										Mixed Desert Shrub	Pasture Hayfield	Riparian	Aquatic	Barren/ Disturbed
	Mountain					Bunchgrass									
	Conifer	Clearcut	Aspen	Sagebrush	Shrub	Shrub	/Forb	Greasewood	Saltbush						
Hairy Woodpecker	B		B										F		
Downy Woodpecker	F		B										F		
Northern Three-toed Woodpecker	B														
Eastern Kingbird			B	B	B	B	B	B	B				B		
Western Kingbird			B	B		B	B	B	B				B		
Ash-throated Flycatcher			F		F	F		B	B				F		
Say's Phoebe			F	B											B
Willow Flycatcher			B										B		
Least Flycatcher			F										F		
Hammond's Flycatcher	B		B		B								F		
Dusky Flycatcher			B		B								B		
Gray Flycatcher			F	F	F			F	F				F		
Western Flycatcher	B		B		F								B		
Western Wood Pewee	B		B		B								B		
Olive-sided Flycatcher	B		F										F		
Horned Lark			F	B	B	B	B	B	B	B					F
Violet-green Swallow		F ¹	B ¹	F ¹	F ¹	F ¹	F ¹	F ¹	F ¹	F ¹		F	B		F ¹
Tree Swallow	B	F	B	F		F						F ¹	B		F
Bank Swallow												F	B		F
Rough-winged Swallow				F				F	F	F		F	B		F
Barn Swallow			F ¹	F ¹								B ¹	F		
Cliff Swallow			F ¹	F ¹	F ¹		B ¹	F ¹	F ¹			B ¹	B		F ¹
Purple Martin												F	F		F
Gray Jay	B	F	F		F	F	F						F		
Steller's Jay	B		F	F	F								B		
Scrub Jay	F														
Black-billed Magpie	F	F	B	B	B			B	B	B		F	B		F
Common Raven	B	B	B	B	B	B	B	B	B	B		B	B		F
Common Crow			B	B		B							B		
Pinyon Jay	F			F	F			F	F	F			F		
Clark's Nutcracker	B		B		F								F		F
Black-capped Chickadee	B		B	F	F								B		
Mountain Chickadee	B		B		F								F		
Plain Titmouse					F								F		
Bushtit					F								F		
White-breasted Nuthatch	B		B										B		
Red-breasted Nuthatch	B		B		F								F		
Pygmy Nuthatch	B		F										F		
Brown Creeper	B		F												F
Dipper	B ¹												B		B

TABLE 1-9 (CONTINUED)

SPECIES	Wildlife Habitat Type										Mixed Desert Shrub	Pasture Hayfield	Riparian	Aquatic	Barren/ Disturbed
	Conifer	Clearcut	Aspen	Sagebrush	Mountain		Bunchgrass /Forb	Greasewood	Saltbush						
					Shrub										
House Wren			B		F							B			
Bewick's Wren					B							B			B
Long-billed Marsh Wren											B				
Canyon Wren				F	F			F	F	F					B
Rock Wren				F	F			F	F	F					B
Gray Catbird															
Sage Thrasher				B	B			B	B	B					
American Robin	B	F	B	B	B		F	B	B	B	F				F
Hermit Thrush	B		F												
Swainson's Thrush	B		B												
Veery	F		B										B		
Western Bluebird	F														
Mountain Bluebird	R	F	R	F	F		F	F	F	F	F		F		F
Townsend's Solitaire	B		B		F										
Blue-gray Gnatcatcher					F										
Golden-crowned Kinglet	B		F												
Ruby-crowned Kinglet	B		F		F		B				F				
Water Pipit															
Sprague's Pipit													F		
Bohemian Waxwing														F	
Cedar Waxwing			B											B	
Northern Shrike				F			F		F		F		F	F	
Loggerhead Shrike				B	B			B	B	B	F		F	F	
Starling			B												
Solitary Vireo	B		B								B		F	F	
Red-eyed Vireo			B											B	
Warbling Vireo	F		B		F								B	B	
Tennessee Warbler			F		F								F	F	
Orange-crowned Warbler	F		B		F								B	B	
Nashville Warbler			F		F								F	F	
Virginia's Warbler															
Northern Parula					F									F	
Yellow Warbler			B		F								B	B	
Yellow-rumped Warbler	B		F		F								F	F	
Black-throated Gray Warbler					F										
Townsend's Warbler	F														
Ovenbird			F										F	F	
Northern Waterthrush			F										F	F	
MacGillivray's Warbler	B		B		B						F		B	B	
Common Yellowthroat															B

TABLE 1-9 (CONTINUED)

SPECIES	Wildlife Habitat Type										Barren/ Disturbed	
	Conifer	Clearcut	Aspen	Sagebrush	Mountain Shrub	Bunchgrass /Forb	Greasewood	Saltbush	Mixed Desert Shrub	Pasture Hayfield		Riparian
Yellow-breasted Chat	F		F								B	
Wilson's Warbler	B		B								B	
American Redstart	F		F								B	
House Sparrow				F			F	F		B	B	
Bobolink										B	B	
Western Meadowlark				B	B		B	B	B	B	F	
Yellow-headed Blackbird										F	B	B
Red-winged Blackbird										F	B	B
Northern Oriole											B	
Brewer's Blackbird	F	F	B	B	B	B	B	B	B	B	B	F
Common Grackle				F	F	F	F	F	F	B	B	
Brown-headed Cowbird			B	F	F					B	B	
Western Tanager			B	F	F					B	B	
Rose-breasted Grosbeak	B		F								F	
Black-headed Grosbeak			B		B						B	
Lazuli Bunting			B		B						B	
Evening Grosbeak	B		F		F						B	
Purple Finch	F		F								F	
Cassin's Finch	B		F		F						F	
House Finch	B		B								B	
Pine Grosbeak	B		F									
Gray-crowned rosy Finch						F						F
Black Rosy Finch	F					B						F
Brown-capped Rosy Finch						F						F
Common Redpoll				F	F	F	F	F	F	F		F
Pine Siskin	B		F		F						B	
American Goldfinch			F								B	
Lesser Goldfinch											F	
Red Crossbill	B		F								F	
White-winged Crossbill	F											
Green-tailed Towhee			F	B	B	F	F	F	F		F	F
Rufous-sided Towhee	F		B	F	B						B	
Lark Bunting				B	F		B	B		B		
Savannah Sparrow				F			F	F	F	F	B	
Grasshopper Sparrow												
Vesper Sparrow				B	B	B				B	F	
Lark Sparrow				B	B	B				F		
Black-throated Sparrow				F	F							
Sage Sparrow				B	B	B	B	B	B			F
Dark-eyed Junco	B		B		B	B	B	B	B		B	

TABLE 1-9 (CONTINUED)

SPECIES	Wildlife Habitat Type							Mixed Desert Shrub	Pasture Hayfield	Riparian	Aquatic	Barren/ Disturbed
	Conifer	Clearcut	Aspen	Sagebrush	Mountain Shrub	Bunchgrass /Forb	Greasewood					
Gray-headed Junco	B		B		B					B		
Tree Sparrow									F	F		
Chipping Sparrow	B		B	B	B		F	F		B		
Brewer's Sparrow			F	B	B	F	F	F	F	F		
White-crowned Sparrow	F		F	F	F					B		
White-throated Sparrow												
Fox Sparrow	F	F								F		
Lincoln's Sparrow			F		F		F	F		B		
Song Sparrow	F		F	F			F	F	F	B		
McCown's Longspur				F					F			
Snow Bunting				F	F	F	F	F	F	F		

¹Associated with aquatic or riparian situations in these habitats.

R = Reproduction

F = Foraging

B = Both

TABLE 1-9

HABITAT ASSOCIATIONS FOR WILDLIFE SPECIES POTENTIALLY OCCURRING ON THE RILEY RIDGE PROJECT AREA
(AMPHIBIANS)

SPECIES ¹	Wildlife Habitat Type						Mixed Desert Shrub	Pasture Hayfield	Riparian	Aquatic	Barren/ Disturbed
	Conifer	Clearcut	Aspen	Sagebrush	Mountain Shrub	Bunchgrass /Forb	Saltbush				
Blotched Tiger Salamander			F						B	B	
Boreal Toad	F		F	F	F			B	B	B	
Boreal Chorus Frog									B	B	
Northern Leopard Frog								B	B	B	
Spotted Frog									B	B	
Great Basin Spadefoot				B			B		B	B	

(REPTILES)

Short-horned Lizard				B			B				
Northern Sagebrush Lizard				B	B		B				B
Rubber Boa	B		B		B				B		
Western Yellowbelly Racer								B	B		
Great Basin Gopher Snake				B			B	B	B		
Wandering Garter Snake			B	B	B			B	B	F	

¹All species require either perennial or ephemeral aquatic habit for breeding.

garter snake are associated with riparian zones. The northern sagebrush lizard and short-horned lizard occur throughout the area's drier habitats.

SITE SPECIFIC

The regional description of the affected environment centers around a discussion of animal groups and the habitats in which they occur. In this section important wildlife or habitat characteristics are identified under specific project components to serve as a basis of comparison. Vegetation communities and wildlife habitats of each component are presented in Table 1-1. Important wildlife areas occurring within the well field are presented on Figure 1-1. Similar information for the plant sites and transportation corridors is presented by alternative on Figures 1-2 through 1-5. Maps 1-1 through 1-5 (see Map Pocket) also depict important wildlife areas in relation to project components.

WELL FIELD UNITS

Hogsback Unit - Mobil

- Elk critical winter/yearlong range
- Moose critical winter/yearlong ranges
- Mule deer critical winter range

Graphite Unit - Exxon

- Elk critical winter range

Dry Piney Unit - Exxon

- Moose critical winter/yearlong range

Fogarty Creek Unit - Exxon

- Elk critical winter/yearlong range
- Elk parturition or calving area
- Moose critical winter/yearlong range

Lake Ridge Unit - Exxon

- Elk critical winter/yearlong range
- Elk parturition or calving area

Tip Top Unit - Mobil

- Elk critical winter range
- Elk parturition or calving area
- Moose critical winter range
- Mule deer critical winter range

Riley Ridge Unit - American Quasar

- Elk critical winter range
- Elk parturition or calving area
- Moose critical winter range

Sawmill Area - Williams

- Elk critical winter range
- Elk parturition or calving area
- Moose critical winter range

PROJECT COMPONENTS	IMPORTANT WILDLIFE AREAS	WELL FIELD									
		Hogsback Unit	Graphite Unit	Dry Piney Unit	Fogarty Creek Unit	Lake Ridge Unit	Tip Top Unit	Riley Ridge Unit	Sawmill Unit	Darby Mountain Unit	North Riley Ridge Unit
Eik Critical Winter Range		●	●		●	●	●	●	●	●	●
Eik Calving Area		●		●	●	●	●	●	●		●
Moose Critical Winter Range		●					●				
Mule Deer Critical Winter Range										●	
Bighorn Sheep Critical Winter Range											
Pronghorn Critical Summer Range							●	●	●		
Sage Grouse Strutting Ground					●		●	●	●		
Sage Grouse Critical Range							●	●	●		
Bald Eagle Wintering Concentration Area											
Potential Black-footed Ferret Habitat		●					●				
Golden Eagle Nest							●			●	
Raptor Nest											
National Wildlife Refuge											

FIGURE 1-1. IMPORTANT WILDLIFE AREAS IN RELATION TO RILEY RIDGE PROJECT COMPONENTS*

Note: Transportation corridor information is presented by alternative on Figures 1-2 to 1.5.

PROPOSED ACTION	IMPORTANT WILDLIFE AREAS										
	Elk Critical Winter Range	Elk Calving Area	Moose Critical Winter Range	Mule Deer Critical Winter Range	Bighorn Sheep Critical Winter Range	Pronghorn Critical Winter Range	Pronghorn Critical Winter Range	Sage Grouse Critical Summer Range	Sage Grouse Strutting Ground **	Bald Eagle Wintering Concentration Area	Potential Black-footed Ferret Habitat
<u>PLANT SITES</u>											
East Dry Basin			●		●					●	
W. Dry Basin								●		●	
Big Mesa			●								
Craven Creek					●					●	
<u>LINEAR FACILITIES ***</u>											
RR-CC						●				●	
TL-1	●		●	●	●	●	●	●		●	
TL-2			●	●	●						●
TL-EDB			●	●	●						
TL-WDB			●	●				●		●	
TL-BM			●		●					●	●
TL-SL					●	●				●	
TL-N-CC						●				●	
SG-EDB-Q			●		●			●			
SG-EDB-W			●		●			●			
SG-BM			●								
SG-CC	●		●	●	●	●		●		●	
S-CC						●		●		●	
CS-EDB			●		●						
CS-1			●	●	●	●				●	
CS-2					●	●				●	
CS-3					●					●	
CS-WDB			●					●		●	●
CS-BM			●	●	●						
C-CC					●	●				●	●
SP-1	●		●	●	●	●	●	●		●	
SP-WDB			●	●				●			
SP-EDB-WDB			●					●			
SP-BM											
W-CC						●		●		●	
A-CC						●				●	
A-BM			●	●							
<u>COMPONENT ALTERNATIVES</u>											
RR-WDB			●	●	●	●		●	●	●	●
C-WDB											
C-EDB					●			●			
C-BM			●								

**Conflict occurring within 1-mile wide study corridor

FIGURE 1-2 IMPORTANT WILDLIFE AREAS IN RELATION TO THE PROPOSED ACTION

IMPORTANT WILDLIFE AREAS BUCKHORN ALTERNATIVE	Elk Critical Winter Range Elk Calving Area Moose Critical Winter Range Mule Deer Critical Winter Range Bighorn Sheep Critical Range Pronghorn Critical Range Pronghorn Critical Winter Range Sage Grouse Critical Summer Range Sage Grouse Strutting Ground ** Bald Eagle Critical Range Potential Black-footed Ferret Habitat Golden Eagle Nest Concentration Raptor Nest ** National Wildlife Refuge													
<u>PLANT SITES</u>														
Buckhorn														
W. Dry Basin														
E. Dry Basin														
Craven Creek														
<u>LINEAR FACILITIES ***</u>														
RR-CC														
TL-1														
*TL-BH														
TL-2														
TL-WDB														
TL-EDB														
TL-SL														
TL-N-CC														
*SG-BH-Q														
*SG-BH-W														
*SG-EDB-E														
SG-CC														
S-CC														
CS-WDB														
CS-1														
CS-2														
CS-3														
CS-BH														
CS-EDB														
C-CC														
SP-1														
*SP-2														
*SP-EDB														
SP-EDW-WDB														
*SP-BH														
W-CC														
A-CC														
*A-BH														
<u>COMPONENT ALTERNATIVES</u>														
C-WDB														
*C-BH														

*Differs from Proposed Action

**Conflict occurring within 1-mile wide study corridor

***See Appendix

FIGURE 1-3. IMPORTANT WILDLIFE AREAS IN RELATION TO THE BUCKHORN ALTERNATIVE

SHUTE CREEK ALTERNATIVE	IMPORTANT WILDLIFE AREAS														
		Elk Critical Winter Range	Elk Calving Area	Moose Critical Winter Range	Mule Deer Critical Winter Range	Bighorn Sheep Critical Winter Range	Pronghorn Critical Winter Range	Pronghorn Critical Winter Range	Sage Grouse Critical Summer Range	Sage Grouse Strutting Ground **	Bald Eagle Critical Range Area	Potential Black-footed Ferret Habitat	Golden Eagle Nest **	Raptor Nest **	National Wildlife Refuge
<u>PLANT SITES</u>															
Buckhorn															
Shute Creek															
Craven Creek															
<u>LINEAR FACILITIES***</u>															
RR-CC															
TL-1															
*TL-BH															
*TL-SC															
TL-SL															
TL-N-CC															
*SG-BH-Q															
*SG-BH-W															
*SG-SC															
SG-CC															
S-CC															
*CS-BH															
CS-2															
CS-3															
*CS-SC															
C-CC															
SP-1															
*SP-2															
*SP-BH															
*SP-SC															
W-CC															
A-CC															
*A-SC-W															
*A-SC-S															
*A-SC-N															
*A-BH															
<u>COMPONENT ALTERNATIVES</u>															
*RR-SC															
*C-BH															
*C-SC															

*Differs from Proposed Action

**Conflict occurring within 1-mile wide study corridor

***See Appendix

FIGURE 1-4. IMPORTANT WILDLIFE AREAS IN RELATION TO THE SHUTE CREEK ALTERNATIVE

IMPORTANT WILDLIFE AREAS NORTHERN ALTERNATIVE	Elk Critical Winter Range Elk Calving Area Moose Critical Winter Range Mule Deer Critical Winter Range Bighorn Sheep Critical Winter Range Pronghorn Critical Winter Range Pronghorn Critical Winter Range Sage Grouse Critical Summer Range Sage Grouse Strutting Ground ** Bald Eagle Wintering Concentration Area Potential Black-footed Ferret Habitat Golden Eagle Nest** Raptor Nest** National Wildlife Refuge													
PLANT SITES														
Buckhorn														
W. Dry Basin														
Big Mesa														
E. Dry Basin														
LINEAR FACILITIES ***														
TL-1														
TL-2														
TL-WDB														
*TL-BH														
TL-BM														
TL-EDB														
TL-SL														
*SG-BH-Q														
*SG-BH-W														
SG-BM														
*SG-EDB-N														
CS-WDB														
CS-1														
CS-2														
CS-3														
*CS-BH														
CS-BM														
CS-EDB														
*S-EDB														
SP-1														
SP-WDB														
SP-EDB														
*SP-BH														
SP-BM														
SP-EDB-WDB														
*A-BM														
*A-BH														
COMPONENT ALTERNATIVES														
C-BM														
C-WDB														
*C-BH														

*Differs from Proposed Action

**Conflict occurring within 1-mile wide study corridor

***See Appendix

FIGURE 1-5. IMPORTANT WILDLIFE AREAS IN RELATION TO THE NORTHERN ALTERNATIVE

Proposed Darby Mountain Unit - American Quasar

- Bighorn sheep critical winter/yearlong range
- Elk parturition or calving area

Proposed North Riley Ridge Unit - American Quasar

- Elk critical winter range
- Elk feed ground
- Elk parturition or calving area
- Moose critical winter range

PLANT SITES

West Dry Basin

- Sage grouse critical range (within 2 miles of strutting ground)
- Elk winter range (adjacent to critical winter range)
- Mule deer winter/yearlong range and migration route
- Pronghorn summer range
- Potential black-footed ferret habitat (prairie dog town)

East Dry Basin

- Mule deer critical winter range
- Pronghorn critical winter range
- Elk winter range
- Potential black-footed ferret habitat (prairie dog town)

Big Mesa

- Mule deer critical winter range
- Adjacent to moose critical winter range
- Elk winter range (also observed during summer)
- Pronghorn summer range

Craven Creek

- Pronghorn critical summer range
- Potential black-footed ferret habitat (prairie dog town)

Buckhorn

- Pronghorn summer range

Shute Creek

- Pronghorn summer range
- Potential black-footed ferret habitat (prairie dog town)

TRANSPORTATION CORRIDORS

Transportation corridors for each alternative are identified with their relationships to important wildlife areas on Figures 1-2 to 1-5. Corridor CS-SC, the CO₂ and sales gas pipelines from the Shute Creek plant, pass through approximately 2.5 miles of the Seedskaadee Wildlife Refuge. Corridor RR-WDB the railroad sulfur transport component alternative passes through approximately 4 miles of the refuge.

SIGNIFICANCE CRITERIA

Although this chapter identifies the impacts expected as a result of the proposed and alternative actions, it is necessary to indicate which of these are considered "significant." The concept of significance as related to wildlife resources must consider the potential severity of the impact in both biological and social (or human) contexts. A symposium on the definition of biological significance (Buffington 1976) resulted in the following definition quoted from Thompson (1978): "A biologically significant impact is one which is long term and which results in a measurable change in carrying capacity or ultimate population size." Certain species are considered important based on their economic or recreational value or their status as a protected, rare, threatened, or endangered species. Certain habitats are considered important based on their relative scarcity in a region, or on the dependence of an important species or group of species on them. Significance criteria for the Riley Ridge Project are:

- Impacts to wildlife are considered significant if critical ranges (wintering areas, parturition grounds, strutting grounds) are affected during season of use, or if critical range disturbance within the well field is determined to be greater than 1 percent of that habitat within the affected geographic region (generally a big game herd unit).
- Impacts to elk and elk spring-summer-fall habitats are considered significant if there is a relative decrease in "habitat effectiveness" of greater than 20 percent as determined by application of Forest Service (FS) forage/cover habitat evaluation methodologies. The 20 percent relative decrease figure for significance is based upon the professional judgement of FS wildlife biologists and relates to Bridger-Teton National Forest objectives for managing wildlife habitat.
- Indirect impacts caused by human population increases are considered to be significant if the estimated increases in poaching, wanton killing, and harassment would exceed 15 percent over expected baseline levels. At present, no research data have been established regarding significant increases in these secondary impacts caused from population increases of energy development projects. Therefore, the 15 percent figure is based on professional judgement. Additionally, this same criteria has been used in previous EISs.
- Impacts to threatened or endangered species are considered significant if the Biological Assessment required under Section 7 of the Endangered Species Act determines that the species are in a "may affect" category. The Biological Assessment is being prepared by the FS, BLM, and the Fish and Wildlife Service will

respond with a biological opinion which will be included as part of the final EIS, and appended to the Wildlife and Fisheries Technical Report.

- Impacts to riparian habitat are considered significant if more than 1 percent of this habitat occurring within the well field is disturbed during project construction. The 1 percent figure was determined independently by FS and BLM wildlife biologists and plant ecologists with input from WGF. It is based on professional judgement and the importance to wildlife and relative scarcity of this habitat within the project area.
- Impacts to aspen habitat are considered significant if more than 1 percent of this habitat occurring within the well field suffers a loss of regenerative capacity (through loss of parent rootstock) during project construction (assumes 0 percent regenerative capacity on well pad disturbances, 25 percent on road disturbances and 100 percent on gathering system disturbances).

Several aspects of the Riley Ridge Project would result in significant adverse impacts to wildlife within the project area including primary impacts of big game critical habitat disturbance and disturbance of important vegetation, and the secondary impacts of increased human population and the accompanying human disturbance to wildlife in the form of increased hunting and fishing pressure, game violations, poaching, wanton killing, harassment, road usage, oversnow vehicle use, vehicle-animal collisions, and unintentional disturbance.

PROPOSED ACTION

WELL FIELD

Construction

Wildlife habitat losses within the well field resulting from development of the Proposed Action are presented in Table 2-1. Habitat losses associated with construction of all facilities comprising the Proposed Action total 12,852 acres of which 3,968 acres would be in the well field (Table 2-2). The sagebrush habitat would be the most affected habitat and represents over 48 percent of the total disturbed well field acreages followed by conifer (27 percent), and bunchgrass/forb (9 percent).

Disturbances to riparian and aspen habitats would affect 135 and 190 acres, respectively (Tables 2-1, 2-2). For riparian, this would constitute 2.4 percent of the 5,608 acres of riparian habitat within the well field, a significant impact (see Significance Criteria). Disturbances to aspen habitat would result in the loss of regenerative capacity through the destruction of parent rootstock on 75 acres or 0.8 percent of the 9,132 acres of aspen habitat within the well field. This would not exceed the significance criteria of 1 percent.

On-going sweet gas and oil development within the well field between 1983 and 1990 was considered in determining significance of disturbance impacts to riparian and aspen habitats and big game critical ranges. The percentage of disturbance was not affected.

TABLE 2-1

ACRES OF WILDLIFE HABITAT PRESENT, DISTURBED, AND PERCENT DISTURBED WITHIN THE WELL FIELD AREA

Wildlife Habitat Type	WELL FIELD UNITS									Total
	Darby Mountain ¹	N. Riley Ridge ¹	Riley Ridge	Lake Ridge	Fogarty Creek	Dry Piney	Graphite	Sawmill ²	Tip Top	Hogsback
Conifer										
Present	11,788	7,609	3,155	11,997	4,813	1,018	1,522	102	89	666
Disturbed	181	70	49	494	156	44	60	3	2	13
% Disturbed	1.5%	0.9%	1.6%	4.1%	3.2%	4.3%	3.9%	2.9%	2.2%	2.0%
42,759										
1,072										
2.5%										
2.5%										
Clearcut										
Present	1,235	134	448	326	45	6	352	0	0	0
Disturbed	11	2	17	20	3	0	12	0	0	0
% Disturbed	0.1%	1.5%	3.8%	6.1%	6.7%	0%	3.4%	0%	0%	0%
2,546										
65										
2.6%										
Aspen										
Present	134	2,803	1,139	973	1,395	672	429	1,203	358	26
Disturbed	1	21	34	30	44	12	20	18	9	1
% Disturbed	0.7%	0.7%	3.0%	3.1%	3.2%	1.8%	4.7%	1.5%	2.5%	3.8%
9,132										
190										
2.1%										
Sagebrush										
Present	986	4,712	8,857	5,524	7,772	5,207	774	10,608	27,718	9,017
Disturbed	21	94	178	244	291	177	3	215	555	156
% Disturbed	2.1%	2.0%	2.0%	4.4%	3.7%	3.4%	0.4%	2.0%	2.0%	1.7%
81,175										
1,934										
2.4%										
Mountain shrub										
Present	538	0	0	0	0	0	0	0	634	538
Disturbed	0	0	0	0	0	0	0	0	20	1
% Disturbed	0%	0%	0%	0%	0%	0%	0%	0%	3.2%	0.2%
1,710										
21										
1.2%										
Bunchgrass/Forb										
Present	1,370	2,400	1,427	1,274	1,408	115	550	269	896	806
Disturbed	0	15	18	120	148	0	11	5	9	41
% Disturbed	0%	0.6%	1.3%	9.4%	10.5%	0%	2.0%	1.9%	1.0%	5.1%
10,515										
367										
3.5%										

TABLE 2-1 (CONTINUED)

Wildlife Habitat Type	WELL FIELD UNITS											
	Darby Mountain ¹	N. Riley Ridge ¹	Riley Ridge	Lake Ridge	Fogarty Creek	Piney	Dry	Graphite	Sawmill ²	Tip Top	Hogsback	Total
Greasewood	0	0	0	0	0	0	0	0	0	256	0	256
	0	0	0	0	0	0	0	0	0	10	0	10
	0%	0%	0%	0%	0%	0%	0%	0%	0%	3.9%	0%	3.9%
Pasture/Hayfield	0	198	435	0	166	26	0	0	3,712	1,210	0	5,747
	0	7	3	0	1	2	0	0	94	67	0	174
	0%	3.5%	0.7%	0%	0.6%	7.7%	0%	0%	2.5%	5.5%	0%	3.0%
Riparian	442	1,024	557	896	262	237	0	0	1,332	679	179	5,608
	15	8	18	38	0	10	0	0	24	20	2	135
	3.4%	0.8%	3.2%	4.2%	0%	4.2%	0%	0%	1.8%	2.9%	1.1%	2.4%
Barren/Disturbed	397	0	0	0	0	0	0	13	0	0	0	410
	0	0	0	0	0	0	0	0	0	0	0	0
	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
Aquatic	70	0	0	0	0	0	0	0	0	0	0	70
	0	0	0	0	0	0	0	0	0	0	0	0
	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
TOTAL	16,960	18,880	16,018	20,990	15,861	7,281	3,640	17,226	31,840	11,232	159,928	159,928
Present	229	217	317	946	643	245	106	359	692	214	3,968	3,968
Disturbed	1.4%	1.1%	2.0%	4.5%	4.1%	3.4%	2.9%	2.0%	2.2%	1.9%	2.5%	2.5%

Note: Present habitats determined from 1982 aerial photography.

¹Proposed Unit²Former Unit

TABLE 2-2
ACRES OF WILDLIFE HABITAT DISTURBED BY PROPOSED ACTION AND ALTERNATIVES

PROPOSED ACTION	Conifer	Clearcut	Aspen	Sagebrush	Mountain Shrub	Bunchgrass/ Forb	Greasewood	Saltbush	Pasture/ Hayfield	Riparian	Aquatic	Mixed Desert Shrub	Barren/ Disturbed	Total
Well Field Plant Sites ¹	1,072	65	190	1,934	21	367	10	-	174	135	-	-	-	3,968
Corridors	-	-	-	2,142	26	113	-	282	-	34	-	144	59	2,800
Total	1,072	65	190	5,249	-	110	155	308	77	80	-	101	4	6,084
				9,325	47	590	165	590	251	249	-	245	63	12,852
BUCKHORN ALTERNATIVE														
Well Field Plant Sites ¹	1,072	65	190	1,934	21	367	10	-	174	135	-	-	-	3,968
Corridors	-	-	-	2,276	-	5	-	282	-	34	-	144	59	2,800
Total	1,072	65	190	5,373	-	93	129	329	103	83	-	101	4	6,215
				9,583	21	465	139	611	277	252	-	245	63	12,983
SHUTE CREEK ALTERNATIVE														
Well Field Plant Sites ¹	1,072	65	190	1,934	21	367	10	-	174	135	-	-	-	3,968
Corridors	-	-	-	1,158	-	463	-	125	-	34	-	321	59	2,160
Total	1,072	65	190	4,671	-	126	125	614	118	67	-	262	4	5,987
				7,763	21	956	135	739	292	236	-	583	63	12,115
NORTHERN ALTERNATIVE														
Well Field Plant Sites ¹	1,072	65	190	1,934	21	367	10	-	174	135	-	-	-	3,968
Corridors	-	-	-	2,286	26	113	-	282	-	34	-	-	59	2,800
Total	1,072	65	190	5,584	-	97	166	238	73	88	-	36	-	6,282
				9,804	47	577	176	520	247	257	-	36	59	13,050

¹Includes sulfur loadout facility.

Removal of habitat would result in the direct destruction of small, less mobile species such as small mammals, bird nestlings, reptiles and amphibians, and the displacement of larger more mobile species such as fledged birds, small game, predatory mammals, and big game. Animals that would primarily be impacted are those utilizing sagebrush habitats. These species include sage grouse, pronghorn, white-tailed jack rabbit, small mammals, and a variety of songbirds (see Chapter 1). Noise produced along roads and on well pads or other facilities would affect animal distributions to a certain extent.

The greatest impact of habitat removal and disturbance to other wildlife would be the loss of nesting or breeding habitat. For roads and permanent facilities where reclamation would not occur within the life of the project, this loss of habitat would be long term. Assuming surrounding suitable habitats are at carrying capacity, displaced animals may not be successful in establishing territories in areas suitable for survival and reproduction. This would result in a reduction in local populations.

Along pipeline and other revegetated rights-of-way, impacts would be less severe. Construction may still result in temporary reduced local populations, but after rights-of-ways are stabilized and revegetated (within 2-5 years of construction), conditions would favor certain species adapted to disturbed or seral vegetative communities. This would result in local changes in abundance and distribution of animal populations. Losses of critical ranges may take many more years to be adequately reclaimed in terms of wildlife habitat, thus all critical range disturbances are considered long-term impacts.

Habitat loss in unique or restricted habitats, such as riparian areas, could have a disproportionate impact on wildlife given the limited distribution and great importance of these areas to a variety of wildlife. Pipeline corridors would be expected to reclaim without major problem but construction requiring major earthwork such as well pads or roads would alter soil strata, modify subsurface water movement mechanics, and cause considerable compaction, resulting in extreme difficulties in reclaiming disturbed areas to riparian habitat. In certain cases riparian reclamation may not be possible. According to development plans, well pads would be located outside riparian habitats. However, 34 acres of riparian habitat would be disturbed by construction of the sulfur loadout facility (Table 1-1).

Aspen is also considered an important wildlife habitat type in the Riley Ridge study area. It supports high diversities of non-game birds and mammals and is valuable for big game. Certain project construction activities would remove or destroy aspen rootstock resulting in extremely long regeneration times in those areas. Aspen reproduces primarily by suckering from existing rootstock and only in very unusual circumstances will reproduction from seed occur, thus, loss or destruction of rootstock such as would occur during well pad or road construction would be a serious impact. Assumptions (see Significance Criteria) applied to disturbance figures (Table 2-1) yield 75 acres of aspen rootstock lost or less than 1.0 percent of the aspen occurring within the well field, under the significance criterion threshold.

Habitat removal is particularly detrimental when it involves loss of critical ranges used for wintering or breeding. Critical ranges are often the limiting factor in maintaining wildlife populations, thus even small losses of critical ranges may result in wildlife population reductions. Table 2-3 presents well field critical range losses as a result of the Proposed Action for elk, mule deer, and moose. Table 2-4 summarizes all critical range disturbances for the Proposed Action. Figure 1-2 displays potential wildlife conflicts off the well field.

Approximately 1,019 acres of elk critical winter range would be disturbed during well field construction activities (Map 1-1, see Map Pocket). This represents a long-term loss of 1.9 percent of the 55,000 acres of critical winter range in the Piney Elk Herd Unit. This would exceed the significance criteria of 1 percent and constitute a significant impact to elk populations in the Riley Ridge project area.

In addition to impacts from habitat loss, impacts of increased road access, traffic, and human disturbance would result in remaining habitat not used to its full potential by elk, and increased stress on elk. This habitat loss and increased stress would constitute an additional impact and result in a decreased in the local elk population.

Assuming a direct, linear relationship between critical winter range and population size, and a zone of influence which reflects a species' behavioral reaction to human activity and noise, the elk population within the well field would be reduced by 63 animals for the 40-year duration of well field construction and operation and result in a productivity loss of 632 elk during that period.

Elk parturition or calving areas would also be affected (Map 1-1, see Map Pocket) resulting in disturbance of 1,107 acres (1.1 percent) of the 102,400 acres of elk calving grounds within the herd unit, just over the significance criterion threshold of 1.0 percent. Impacts of increased road access, traffic, and associated human disturbance in elk calving areas have an even greater potential for affecting elk calving success and would likely result in an unquantifiable reduction of elk calves joining the population annually.

Project impacts to elk and other big game habitats were identified during the scoping process as a subject of high concern. Special efforts were made to quantitatively evaluate habitat changes as a result of the Proposed Action. Results of application of the technique "Estimating Effects of Habitat Changes on Potential Elk Use in Wyoming" (Chapter 3) are presented in Table 2-5. This method combines effects of habitat removal and human disturbance due to roads and predicts changes in potential elk use of an area stated as a percent habitat effectiveness.

Elk habitat within the well field would decrease from 38.2 percent to 31.7 percent habitat effectiveness, a relative change of 17 percent (Table 2-5). The impacts would predominantly be due to increased road access into the area. New roads into the area and upgraded existing roads would improve access to almost every portion of the elk habitat. Approximately 91 percent of the entire well field would be within the influence zone of roads (within

TABLE 2-3

ACRES OF BIG GAME CRITICAL RANGE IMPACTS OF PROPOSED WELL FIELD DEVELOPMENT

Critical Range	Darby Mountain ²	North Riley Ridge ²	Riley Ridge	Lake Ridge	Fogarty Creek	Dry Piney	Graphite	Sawmill ³	Tip Top	Hogsback	Total
Elk Critical Winter Range											
Acres present in well field unit	0	5,997	4,339	3,302	5,235	149	3,162	1,194	2,644	6,349	55,000 Ac ¹
Acres disturbed	0	70	105	142	287	12	92	26	167	118	32,371
% of well field unit disturbed	0	1.2	2.4	4.3	5.5	7.7	2.9	2.2	6.3	1.9	1,019
% disturbed by herd unit	0	0.1	0.2	0.3	0.5	0.02	0.2	0.05	0.3	0.2	3.1
Elk Critical Calving Range											
Acres present in well field unit	1,971	11,859	6,566	10,970	7,606	0	0	2,874	452	0	102,400 Ac ¹
Acres disturbed	55	188	158	365	275	0	0	53	13	0	42,298
% of well field unit disturbed	2.8	1.6	2.4	3.3	3.6	0	0	1.8	3.0	0	1,107
% disturbed by herd unit	0.05	0.2	0.2	0.4	0.3	0	0	0.05	0.01	0	2.6
Mule Deer Critical Winter Range											
Acres present in well field unit	0	0	0	0	0	0	0	0	1,798	5,702	468,000 Ac ¹
Acres disturbed	0	0	0	0	0	0	0	0	44	98	7,500
% of well field unit disturbed	0	0	0	0	0	0	0	0	2.1	1.7	142
% disturbed by herd unit	0	0	0	0	0	0	0	0	0.008	0.02	1.9
Moose Critical Winter Range											
Acres present in well field unit	0	2,003	3,379	0	1,920	0	0	3,872	3,686	826	312,000 Ac ¹
Acres disturbed	0	0.2	33	0	72	0	0	76	86	20	15,686
% of well field unit disturbed	0	0.01	1.0	0	3.7	0	0	1.9	1.9	2.4	287
% disturbed by herd unit	0	<0.001	0.01	0	0.02	0	0	0.02	0.02	0.006	1.8
										0.006	0.09

Note: Critical ranges acreages were determined from 1982 WGF habitat mapping.

¹Total acreages of these critical ranges in affected big game herd units.²Proposed units.³Former unit.

TABLE 2-4
ACRES OF WILDLIFE CRITICAL RANGES¹ DISTURBED
PROPOSED ACTION

	Well Field	Plant Sites ²	Corridors	Total
Elk Critical Winter Range	1,019	0	460	1,479
Elk Critical Calving Range	1,107	0	0	1,107
Mule Deer Critical Winter Range	142	1,060	1,755	2,957
Moose Critical Winter Range	287	0	299	586
Pronghorn Critical Winter Range	0	640	1,641	2,281
Pronghorn Critical Summer Range	0	840	1,051	1,891
Prairie Dog Towns	0	191	388	579

¹Critical ranges may overlap between species.

²Includes sulfur loadout.

TABLE 2-5

PERCENT CHANGE IN FORAGE/COVER RATIOS AND ELK HABITAT EFFECTIVENESS¹ ON FS AND BLM LANDS
DUE TO PROPOSED WELL FIELD DEVELOPMENT

FS Land	Southern Portion			Western Portion			Eastern Portion			Total	
	Existing	Development	% Change	Existing	Development	Change	Existing	Development	% Change	Existing	Development
Forage/Cover	67/33	63/37	6	50/50	50/50	0	51/49	51/49	0	53/47	53/47
% Elk Habitat Effectiveness	45.4	45.4	0	78.7	75.7	4	46.8	0	100	65.3	52.0
											20.4
BLM Land	Southern Portion			Central Portion			Northern Portion			Total	
	Existing	Development	% Change	Existing	Development	Change	Existing	Development	% Change	Existing	Development
Forage/Cover	89/11	89/11	0	67/33	65/35	3	68/32	68/32	0	75/25	75/25
% Elk Habitat Effectiveness	26.0	26.0	0	6	5	16.7	4.8	4.8	0	12.9	12.7
											1.5
All Well Field Elk Habitats											
Existing Development % Change											
Forage/Cover	64/36	64/36	0								
% Elk Habitat Effectiveness	38.2	31.7	17.0								

¹Method from "Estimating Effects of Habitat Changes on Potential Elk Use in Western Wyoming", FS 1981.

0.9 mile of a road). The presence of more roads open to vehicular traffic would increase the avoidance reaction of elk, resulting in a portion of available habitat not used to its full potential.

The FS land would have a relative decrease of 20.4 percent (from 65.3 to 52.0 percent) in elk habitat effectiveness as a result of the Proposed Action (Table 2-5). This area is good summer elk habitat, and the disturbance of increased access would significantly decrease the value of the habitat for elk.

The southern portion of the FS land, including parts of Lake Ridge and Fogarty Creek Units, demonstrated a 0 percent change in elk habitat effectiveness due to the proposed development (see discussion of methodology limitations on 1-9 and 1-10). This area has a high amount of road access during snow free periods and a low existing habitat effectiveness during summer and early fall, and the proposed development would not significantly decrease the habitat effectiveness. The western portion, including the proposed Darby Mountain Unit, western proposed North Riley Ridge, and western Lake Ridge Units would have a habitat effectiveness of 75.7 percent after development, a 4 percent relative decrease from existing values (Table 2-5). This area is excellent summer elk habitat, and proposed development is minimal, generally following existing roads. The eastern portion of FS land, including central North Riley Ridge, Riley Ridge, and eastern Lake Ridge Units, would be impacted the most with a 100 percent decrease (from 46.8 to 0 percent) in habitat effectiveness because new roads and pipelines would be built in areas of good elk summer habitat where no roads currently exist.

The BLM land would have a slight decrease in elk habitat effectiveness because the area currently has a great deal of existing disturbance. All portions, including eastern proposed North Riley Ridge, Riley Ridge, and Fogarty Creek Units, Dry Piney, Graphite and Hogsback Units, and western Tip Top Unit would have slight changes because of the level of existing disturbance. New disturbance would be in areas already affected by existing disturbance.

Because this method was designed to address impacts of timber sales on summer and fall elk habitat, disturbances unique to oil and gas development may not be accurately reflected by this analysis. The most critical impacts would develop as a result of new roads and upgraded existing roads, habitat removal for construction of roads and facilities, and increased vehicular use of roads, rather than from changes in habitat of large acreages as in a timber sale. This method does not account for habitat removal or the change in vehicular use of upgraded roads, nor does it always clearly reflect impacts of new roads if those roads are near existing roads. Increased vehicular traffic on the roads and increased maintenance of roads to allow year-round use would cause a large increase in the amount of disturbance to elk. Roads normally closed from snow during the critical calving period would be open, allowing harassment of elk year-round (Hinschberger 1982, personal communication). Harassment during periods of stress, such as calving or wintering, may result in a decrease in productivity and survival, and an unquantified decrease in the size of the population.

Although this method was designed to evaluate impacts on elk, similar trends can be expected for other big game species because of the similarities in habitat requirements and avoidance reactions.

The relationship of forage (non-cover) to cover and the degree of interspersation of those types is also important in evaluating elk habitats. Optimum habitat is generally considered to have a forage/cover ratio of 60/40.

Cover, in particular, can be critical to survival of big game species. Lack of cover exposes individuals to the stress of human harassment, increased harvest, predators, and temperature extremes. Increased stress may result in a decrease in physical fitness and productivity, or even death. When this increased stress occurs in an area of high use during already stressful periods such as wintering or calving, effects on the population may be severe, resulting in an unquantified reduction of big game local populations.

Forage/cover ratios range from 50/50 to 89/11 within well field forested areas with an overall ratio of 64/36 (Table 2-5). Changes in forage/cover ratios would be minimal, with no change in the overall ratio, and very little change in the arrangement and interspersation of habitats, therefore, the change in forage/cover ratio would have no impact on this herd. However, because cover is a limiting factor affecting elk distribution, the removal of cover (or forage, which has the potential to develop cover) would have a negative impact on local populations.

Mule deer critical winter range losses as a result of well field development were determined to be 142 acres (Tables 2-3 and 2-4). This would constitute less than 0.1 percent of the 468,000 acres of mule deer critical winter range within the herd unit, well below significance criteria. Well field habitat losses and human disturbance influences would result in an estimated mule deer population reduction of 29 animals in the well field and a productivity loss of 350 mule deer during construction and operation.

Approximately 287 acres of moose critical winter range would also be disturbed or less than 0.1 percent of the 312,000 acres of moose critical winter range within the herd unit (Tables 2-3 and 2-4). As a result, the moose population would be reduced by 6 animals and productivity losses would amount to 62 animals during construction and operation.

Bighorn sheep use of the well field is limited to the extreme northwestern portion of the area, primarily the tops and steep slopes of Mount Darby and Fish Creek Mountain. Well field development in the area would be very limited. Significant impacts to bighorn sheep are not expected.

Impacts to well field and plant site critical ranges are considered to be long term (i.e., for the life of the project and longer). Habitats associated with critical ranges such as sagebrush, mountain shrub, or willow would require 10 to 50 years to reestablish following rehabilitation of disturbed areas. Within the well field many of these areas would still not be used by big game species because of their behavioral response to human activity. Other, less sensitive species such as song birds and small

mammals would use successfully reclaimed areas as a modified habitat of grasses, forbs, and developing shrubs (see EIS Vegetation Section for more discussion on acreages of habitats disturbed, lost, and reclaimed).

Big game population reductions and productivity losses discussed above were estimated from several simplified assumptions on animal densities, sensitivity to human activity, reproductive potential, and duration of impact (see Chapter 3) and are intended to provide rough estimates or relative impacts and represent the best estimates at our current level of knowledge.

Actual impacts may be different from these estimates. For example, although estimates show only a reduction in elk population, elk may react to the well field development by abandoning the entire range. This abandonment could take place for only a few weeks or months during concentrated development phases, or it could extend over years, causing conflicts within other wildlife management units or feedgrounds.

Other significant impacts would result from the increase in human population and the accompanying human disturbance to wildlife in the form of increased hunting and fishing pressure, game violations, poaching and wanton killing, and vehicle-animal collisions which would directly impact wildlife through population reductions as a result of killing and lower reproductivity. This is an impact which would begin during well field, plant site, and corridor construction and continue for all components throughout operation and abandonment.

Increases in human disturbance to wildlife (poaching and wanton killing) are assumed to be directly related to increases in human population. Therefore, they are predicted to increase by 66, 37, and 3 percent in Sublette, Lincoln, and Sweetwater Counties, respectively, as a result of the Proposed Action for peak project-related population (see EIS Socioeconomics Section). This represents a significant impact in Sublette and Lincoln Counties, well over the significance criteria of 15 percent.

These figures may be conservative because oil and gas construction workers may tend to have a greater impact on the area's wildlife than current residents (EIS Recreation Section). Observations of the outdoor use patterns of construction workers in the Kemmerer area show much greater outdoor use than local residents especially as related to hunting, fishing, and camping (Kominski 1982, personal communication). The Evanston area has experienced a significant increase in poaching and game violations as a result of an influx of construction workers (Smith 1982, personal communication).

The impact of poaching, wanton killing, and harassment on big game populations is generally underestimated. Studies which simulated poaching incidents in California, Idaho, and Maine yielded detection rates of between 1.1 and 2.2 percent (Smith, G. 1982). These studies demonstrated that only one or two poaching violation simulations were reported out of every 100 that took place, which means that there may be 50 times the poaching violations that are detected and reported.

Illegal harvest of big game animals may be equal to or greater than legal harvest in certain high impact areas (Smith, G. 1982). This is particularly true in areas experiencing an influx of temporary construction workers (Smith, J. 1982, personal communication). Kuck (1982), in a study to determine big game habitat preferences as related to phosphate mining in Idaho, reported that 7 of 15 radio-collared deer were either illegally taken or died as a result of crippling, whereas only 2 were taken legally. Of ten elk radios recovered, two were winter kills and the remaining eight were equally divided between legal and illegal kills. At least five of six moose were also killed illegally (Kuck 1982). In light of data such as these, potential poaching impacts as a result of the Riley Ridge Project must be considered severe.

The impact of poaching and wanton killing on game populations is very difficult to estimate. Assumptions on detection rates of poaching violations vary widely (from 2 percent on certain poaching simulation studies to up to 20 percent for certain game law enforcement personnel), so any estimate would represent only order-of-magnitude accuracy. Based on limited existing information and predicted human population increases, about 100 to 1,000 big game animals would be lost annually to poaching and wanton killing as a result of the Riley Ridge Project construction.

Projected increases in hunting demand due to the Riley Ridge Project would result in greater hunting pressure and ultimately in increased harvest of game species. This can be either positive or negative depending upon WGF strategic plans at the time increase harvest occurs. Based on current plans and expected hunting pressure increases, it is likely that increased harvests would be considered a negative impact (see EIS Recreation Section).

Vehicle-wildlife collisions may be numerous in areas of high wildlife use and high human activity. Increased vehicular use of the area would increase the likelihood of collisions. Big game species are of high concern because of their economic and aesthetic importance, and their ability to cause severe damage to vehicles and injure or kill people. Their crepuscular (dawn and dusk) habits also increase the possibility of collisions during periods of poor visibility and peak traffic for commuting workers. Smaller wildlife such as rabbits and grouse would also experience higher mortality from vehicle-wildlife collisions, but this is not expected to affect local population levels.

Counts of big game road kills on Highway 189 between Big Piney and Fontenelle Reservoir were recorded by the Wyoming Highway Department for the winter of 1981-1982. From these numbers there are an estimated 105 mule deer and 15 pronghorn killed each year on that stretch of highway (Johnson 1983, personal communication). Assuming a direct, linear relationship between average annual traffic volume and road kills, 1986 baseline mortality would be 125 deer and 18 pronghorn. With the Proposed Action, estimated additional mortality would be 90 mule deer and 13 pronghorn during 1986, a 72 percent increase over baseline. This represents the peak impact, though impacts of this magnitude would occur throughout the construction phase. Road kill data are unavailable for other highway segments within the project area. This section of Highway 189 would represent the most heavily

impacted road section within the project area based on projected increases in traffic volume and the occurrence of big game winter range. These estimates represent a large portion, but only a portion of total vehicle-wildlife collision mortality that would occur as a result of the Proposed Action.

With increased traffic there is a proportionately increased chance of a vehicle striking the endangered black-footed ferret should they be found to inhabit the project area. Increased traffic and resulting road kills would also increase the chance of vehicles striking and killing wintering bald eagles and other raptors feeding on roadside carrion. Further discussions of endangered species impacts is presented later.

Well field traffic (see EIS Transportation Section) would pass through many categories of critical winter range resulting in an unquantified number of road kills annually.

Operation

Reclamation of areas temporarily disturbed by construction (road edges, well pad perimeters, and gathering system) would begin after construction of each facility. Areas occupied by roads and other life-of-project facilities would remove habitats from wildlife production for the life of the project and longer. Because of continued human presence and activity in the well field, population reductions and productivity losses discussed under well field construction would continue during the operation phase. Reclaimed areas would gradually reestablish into wildlife habitat (see EIS Vegetation Section) used by smaller, less sensitive species. Winter access to well sites and other facilities would continue to disturb animals already stressed by winter conditions. It is expected that elk using Finnegan Feedground on the northern half of the well field would gradually acclimate to well field activity, however, this is unknown.

Impacts of poaching, vehicle-wildlife collisions, and other human disturbance causes would continue through operation but gradually decrease as temporary construction workers are replaced with long-term oil company and contractor employees. By 1995, project-related population would decrease to 38, 9, and less than 1 percent over baseline in Sublette, Lincoln, and Sweetwater Counties, respectively (see EIS Socioeconomics Section). Human disturbance impacts would decrease accordingly.

Traffic volumes on Highway 189 would also be lower than construction levels. An estimated 30 mule deer and 5 pronghorn would be killed by project-related traffic during operation each year on Highway 189 between Big Piney and Fontenelle Reservoir.

Abandonment

At the end of the project, during abandonment, disturbed areas would be reclaimed and revegetated according to agency stipulations. Some habitats would be reestablished within 5 years, but critical ranges relying on shrub habitats such as sagebrush, mountain shrub, or willow would take from 10 to 50 years to become established.

Assuming that human access and activity in the well field would be at near pre-development levels and that critical ranges would take 15 years to reestablish, project impacts during well field abandonment would be a population reduction of 13 elk, 10 mule deer, and 1 moose. Productivity losses of these big game species are estimated to be 49 elk, 44 mule deer, and 5 moose in addition to those lost during construction and operation.

PLANT SITES

Construction

Construction at the plant sites and sulfur loadout facilities for the Proposed Action would remove 2,800 acres (Table 2-2) of wildlife habitat from production (see EIS Vegetation Section). Critical ranges within these areas would be affected with the disturbance of 1,060 acres of mule deer critical winter range, 640 acres of pronghorn critical winter range, and 840 acres of pronghorn critical summer range (Tables 2-4, 2-6, Maps 1-1 through 1-5, see Map Pocket). The loss of mule deer critical winter range would result in a population reduction of 145 mule deer during plant site construction. This would result in a productivity loss of 1,523 deer for the 35-year duration of treatment plant construction and operation. The loss of pronghorn critical winter range would result in a population reduction of 28 pronghorn and a productivity loss of 482. The loss of pronghorn critical summer range cannot be reliably correlated to population reductions or productivity losses. The West Dry Basin plant site, though not deer critical winter range, is important winter range and in a migration area.

Access roads and worker traffic to and from the plant sites would pass through many categories of important wildlife areas (Figure 1-2, Maps 1-1 through 1-5, see Map Pocket) and result in many road kills annually. Plant site access through critical ranges would also increase the opportunity of human disturbance impacts of poaching, wanton killing, and harassment as discussed under well field construction.

Plant site construction would remove 191 acres of prairie dog towns, a potential black-footed ferret habitat (Table 2-4). Because of the acreages of prairie dog towns potentially affected by the Riley Ridge Project (including corridor impacts), the FS and BLM have issued a "may affect" decision in their biological assessment to the Fish and Wildlife Service. Therefore, this EIS recognizes a significant impact to the black-footed ferret (see Significance Criteria). Black-footed ferret surveys would be required in prairie dog towns to be removed or disturbed prior to construction. The FS and BLM are currently evaluating impacts to the other endangered species.

Operation

Plant operation would not disturb additional wildlife habitat. Wildlife population reductions and productivity losses discussed under construction would continue throughout the operation phase. Many human disturbance impacts discussed previously would decline as construction stabilizes into operation.

TABLE 2-6

ACRES OF WILDLIFE CRITICAL RANGES POTENTIALLY DISTURBED BY PLANT SITES

Plant Sites	Elk Critical Calving Range	Elk Critical Winter Range	Moose Critical Winter Range	Mule Deer Critical Winter Range	Pronghorn Critical Winter Range	Pronghorn Critical Summer Range	Prairie Dog Towns
West Dry Basin	0	0	0	0	0	0	71
East Dry Basin							
AQ	0	0	0	640	640	0	22
Ex	0	0	0	640	640	0	22
Buckhorn	0	0	0	0	0	0	0
Big Mesa	0	0	0	420	0	0	0
Shute Creek	0	0	0	0	0	60	65
Craven Creek	0	0	0	0	0	640	68
Sulfur Loadout	0	0	0	0	0	200	30

¹See Appendix A

Plant operation wastewater (contaminated with H₂S, reduced sulfur, and trace metals, see EIS Chapter 1) would be disposed of through permitted deep well injection at American Quasar and Exxon plant sites. Northwest would dispose of its wastewater in a 30-acre evaporation pond at the Craven Creek site. The pond would be attractive to waterfowl, waterbirds, and other wildlife species in the area because of the scarcity of water throughout the region. The water in the pond would be highly toxic to any animals which ingest it, potentially killing an unquantified number of waterfowl, waterbirds, songbirds, small mammals, and big game species (pronghorn or deer) depending upon the proximity of the pond to industrial activity.

Employees traveling to and from work would continue to negatively impact wildlife through disturbance and collision.

Abandonment

At the end of the project when buildings are dismantled and removed and reclamation and revegetation are complete, wildlife habitat would gradually regenerate. Assuming that big game critical range habitats on the plant sites would take 15 years to reestablish following successful revegetation, project impacts during plant site abandonment would be a population reduction of 73 mule deer and 14 pronghorn as compared to pre-development conditions and a corresponding productivity loss of 326 mule deer and 103 pronghorn.

LINEAR FACILITIES

Construction

Construction of roads, pipelines, transmission lines, and other linear facilities off the well field would disturb 6,084 acres of wildlife habitat or 47 percent of the total 12,852 acres disturbed by the Proposed Action (Table 2-2; see EIS Vegetation Section). Disturbance to critical ranges would include 1,755 acres of mule deer critical winter range, 1,641 acres of pronghorn critical winter range, 1,051 acres of pronghorn critical summer range, 460 acres of elk critical winter range, and 299 acres of moose critical winter range (Table 2-4). Construction of these linear facilities would take place over several years so not all of these acreages would be disturbed at any one time. Open trenches will be provided with fill areas so as not to impede animal movements. Corridor disturbances would be reclaimed and revegetated following disturbance and a modified wildlife habitat would exist once revegetation is complete (less than 5 years). Because of the short-term nature of the impact and the fact that there would be little human disturbance along the corridors once construction is completed, big game population reductions and productivity losses are not expected. Similarly, impacts to wild horses would not be significant.

There would be 388 acres of prairie dog towns disturbed during corridor construction resulting in the "may affect" decision regarding impacts to the endangered black-footed ferret as discussed earlier, a significant impact. The sales gas and CO₂ pipeline from East and West Dry Basin (Maps 1-5, see Map Pocket) would cross the Green River which is used by wintering bald eagles, but construction would be of short duration and impacts are not expected.

The transmission line from Naughton Power Plant and the sulfur pipeline would pass near (within $\frac{1}{4}$ mile) a known sage grouse strutting ground west of the Craven Creek plant site, potentially disrupting strutting (reproductive) activity if construction occurs during March through May.

Operation

Following construction, many of the corridors (pipeline, transmission line) would be reclaimed. After rights-of-way are stabilized and revegetated (within 2 to 5 years of construction, see EIS Erosion Control Appendix), conditions would favor species adapted to disturbed or transitional vegetative communities and would result in local changes in abundance and distribution of the smaller animal species.

Transmission line operation may impact whooping cranes, bald eagles, and other birds which may strike transmission wires associated with the project resulting in death or injury (FWS 1978). These birds would be most susceptible to collision when transmission lines cross major drainages or large riparian areas. For the Proposed Action, transmission lines would not cross the Green River, however they would cross Fontenelle Creek and LaBarge Creek. Collisions are most likely to occur during periods of low light levels and poor visibility due to weather, and during periods of migration (Malcolm 1982). Electrocution hazards would be avoided by the H-frame configuration and conductor and ground wire spacing of the transmission towers.

Potential impacts of sour gas ruptures or leaks on wildlife are related to analyses performed for human health and safety (EIS Health and Safety Section). Potential for a rupture or leak along any particular segment of the gathering lines or trunk lines is very small. Because of the mobility of wildlife populations, the probability of effects to wildlife cannot be assessed. If a rupture occurred within a wildlife concentration area during a period of year and time of day when wildlife were concentrated near the rupture, and rupture and meteorological conditions were both the worst possible case, many (but an unknown number of) animals could be lost. Such a possibility does exist, but probabilities are extremely low (see EIS Health and Safety Section) and wildlife impacts are not considered significant.

The above-ground sulfur pipeline would not physically impede animal movements, but certain species (particularly elk) may react behaviorally by not crossing under the line and consequently may limit elk winter range east of the line (Map 1-1, Map Pocket); distribution of mule deer and pronghorn may also be altered. Effects of pipeline breaks would be localized and minimal, thus serious impacts are not expected. Molten sulfur pipeline drain locations occur along low points in the line which often correspond to stream crossings. Drain pits would be located away from riparian areas (See EIS Chapter 1).

Abandonment

Abandonment would cause some localized disturbance on some portions of the transportation corridors as surface facilities are removed; underground facilities would be left in place. Once abandonment is completed and locally disturbed areas are revegetated, wildlife habitats would continue to regenerate. No significant impacts are expected.

CUMULATIVE ASSESSMENT

Potential cumulative impacts of the Riley Ridge Project and other interrelated projects would be minimal. The Chevron Chemical Phosphate Project would result in disturbance of 341 acres of prairie dog towns (with a long-term loss of 198 of those acres) approximately 4 miles southeast of Rock Springs. This, and prairie dog town losses from the Riley Ridge Project, would constitute a cumulative impact of potential habitat reduction for the endangered black-footed ferret. In addition, human population increases from the Phosphate Project and the Bureau of Reclamation's Big Sandy Salinity Project in Sweetwater County, and Exxon's Road Hollow Gas Treatment Plant in Lincoln County would result in cumulative impacts to wildlife through increased poaching, wanton killing, vehicle-wildlife collisions, and harassment.

SUMMARY

Impacts of the Proposed Action to wildlife critical ranges have been summarized in Table 2-4. Significant impacts would include disturbance to elk critical winter range and calving grounds within the well field, disturbance to riparian habitat within the well field, and indirect impacts caused by increased human population within the project area.

Critical winter range disturbances in the well field and plant sites are expected to result in population reductions of 63 elk, 174 mule deer, 6 moose, and 28 pronghorn during construction and operation, and decrease of 13 elk, 83 mule deer, 1 moose, and 14 pronghorn during abandonment. Productivity losses (animals not born and growing to maturity) over the life of the project as a result of the above population reductions would be 681 elk, 2,243 mule deer, 67 moose, and 585 pronghorn. Critical range disturbances along the corridors are not expected to result in population effects because of the short-term nature of the disturbance. Wild horses and bighorn sheep would not experience significance impacts.

In addition, an unquantified number (more than 100 but less than 1,000) of big game animals would be killed annually by poaching and wanton destruction. A similar number would be killed by vehicle-animal collisions due to traffic associated with the Proposed Action. This impact would be greatest during construction and decrease during operation and abandonment.

The FS and BLM have issued a "may affect" decision on potential impacts to the black-footed ferret as a result of predicted disturbances to white-tailed prairie dog towns (potential ferret habitat), a significant impact.

Peregrine falcons would not be expected to be impacted because of their sporadic use of the area and wide-ranging habits. Whooping cranes would not be expected to be impacted because of the small amount of crane habitat loss. Only 35 acres of meadows would be removed from the well field, and other areas of crane habitat should not be seriously affected. The small number of cranes using the area and the sporadic nature of their use would enable whooping cranes to adjust to using other available habitat, however there is a possibility that cranes may strike transmission lines. Project activities would not significantly affect bald eagles because concentrations of eagles occur along the Green River during winter. River crossings are

not planned in the Proposed Action. However, there is a possibility that eagles may strike transmission lines. The FS and BLM are currently evaluating impacts to these species.

Sensitive species, including trumpeter swan, osprey, and great gray owl are not expected to be impacted. Trumpeter swans do not regularly occur in the study area, and great gray owls inhabit coniferous forests at higher elevations where disturbance would be minimal. Osprey migrate along the Green River and are not expected to be impacted.

Overall, implementation of the Riley Ridge Project would result in significant impacts to wildlife. Mule deer, pronghorn, and moose herd sizes in the area would decrease as a result of critical range disturbances, and increasing human populations would increase annual big game mortality. Elk herd size would probably be similarly impacted with the possibility that portions of the well field now used as a natural wintering areas would be abandoned for an unknown time period. Cumulatively, this project would contribute to big game herd size decreases in this part of Wyoming and increase the potential for endangered species impacts.

Sagebrush habitat would be the habitat most affected and represents over 72 percent of the total disturbed acreages for the Proposed Action, followed by conifer (8 percent), saltbush (5 percent), and bunchgrass/forb (5 percent). About 249 acres, or 2 percent of the total habitat loss, would occur in riparian areas. Mountain shrub and clearcut habitats would be the least affected (less than 1 percent), reflecting their limited occurrence in the study area. Conifer, clearcut, and aspen types occur primarily in the well field, and therefore would be equally affected by the Proposed Action and alternatives.

About 75 percent of the total habitat loss can be attributed to construction and operation of on and off well field linear facilities including roads, pipelines, and transmission lines. Plant site construction would remove about 640 acres in any one location. Besides construction of the sulfur loadout facility (240 acres), no other large blocks of habitat would be removed as a result of the Proposed Action. Unlike other types of development (such as mining, reservoir construction, or industrial facility development), oil and gas development results in an extensive network of linear facilities which remove small portions of individual patches of habitat. Therefore, human disturbance associated with construction and use of these linear facilities is usually a significant effect on wildlife in addition to the actual loss or modification of habitat.

COMPONENT ALTERNATIVES

Component alternatives presented here may be applied to any of the four alternatives considered in this chapter.

SULFUR TRANSPORT

Exxon's railroad component alternative to transport sulfur from the northern plant sites would disturb several categories of big game critical range (Table 2-7, Maps 1-1 through 1-5, see Map Pocket) acreage disturbances would account for a population reduction of less than 1 moose, about 12 mule deer, and about 9 pronghorn. Population reductions applied over a 35-year railroad life would result in a productivity loss of 1 to 2 moose, 122 mule deer,

TABLE 2-7

ACRES OF WILDLIFE CRITICAL RANGE¹ POTENTIALLY DISTURBED
BY COMPONENT ALTERNATIVES

	Elk Critical Calving Range	Elk Critical Winter Range	Moose Critical Winter Range	Mule Deer Critical Winter Range	Pronghorn Critical Winter Range	Pronghorn Critical Summer Range	Prairie Dog Towns
<u>Sulfur Transport</u>							
Railroad to West Dry Basin	0	0	39	170	400	121	150
Railroad to Shute Creek	0	0	0	0	0	24	16
<u>Power Supply</u>							
UP&L							
Proposed Action	0	170	48	630	218	182	NA
Buckhorn Alt.	0	170	61	606	267	182	NA
Shute Cr. Alt.	0	194	61	545	230	218	NA
Northern Alt.	0	170	61	691	279	182	NA
BLM							
Proposed Action	0	158	65	558	339	218	NA
Buckhorn Alt.	0	158	77	533	388	218	NA
Shute Cr. Alt.	0	158	77	448	351	240	NA
Northern Alt.	0	158	48	630	400	194	NA
<u>Employee Housing</u>							
West Dry Basin Camp	0	0	0	0	0	0	0
East Dry Basin Camp	0	0	0	0	320	0	0
Buckhorn Camp	0	0	0	0	0	0	0
Big Mesa Camp	0	0	0	80	0	0	0
Shute Creek Camp	0	0	0	0	0	320	0

NA = Not Applicable--These corridors were not sampled for prairie dog towns.

¹Critical ranges may overlap between species.

and 150 pronghorn. In addition, though train traffic is expected to be less than one per day (see Transportation Section), there would likely be an unquantified loss of mule deer and pronghorn to train collisions.

Railroad construction would also disturb 150 acres of prairie dog towns, affecting potential black-footed ferret habitat (Table 2-7). The railroad would pass through approximately 4 miles of the Seedskaadee National Wildlife Refuge and would interfere with refuge goals. Construction and operation of a railroad through the refuge would cause impacts to wildlife and to refuge land use plans (see EIS Land Use Section). Goals of the refuge include development of man-made wetlands and maintenance of existing wetlands. Seedskaadee was created as a mitigation measure for development of Fontenelle and Flaming Gorge Reservoirs and is managed for migrating waterfowl and waterbirds. Construction and operation activities would be disruptive to wildlife species (including bald eagles which concentrate on the Seedskaadee during winter) and would result in wildlife avoidance of the railroad vicinity.

The railroad spur to Shute Creek would disturb 24 acres of pronghorn critical summer range (Table 2-7). Population reductions are not expected. In addition, 16 acres of prairie dog towns would also be disturbed.

POWER SUPPLY

The UP&L Component alternative transmission line would result in impacts similar to those of the proposed and alternative actions' transmission lines. Temporary, short-term disturbance would occur to elk critical winter range, moose critical winter range, mule deer critical winter range, pronghorn winter range, and pronghorn critical summer range (Table 2-7). Big game population reductions or productivity losses are not expected. This route has not been surveyed for prairie dog towns. Potential impacts of wire-strikes for whooping cranes, bald eagles, or other birds are similar to the Proposed Action.

The BLM component alternative transmission line would also result in impacts similar to those of the proposed and alternative actions. Acreages of disturbance are presented on Table 2-7. The BLM component alternative would parallel an existing 69-kilovolt line so the potential for avian wire strikes would be relatively high (McKenna and Allard 1976).

EMPLOYEE HOUSING

The use of construction camps for employee housing at West Dry Basin and Buckhorn would not affect any big game critical ranges. A construction camp at Big Mesa would remove approximately 80 acres of mule deer critical winter range from production for an estimated 5 years. Similarly, East Dry Basin would disturb 320 acres of pronghorn critical winter range, and Shute Creek would disturb 320 acres of pronghorn critical summer range (Table 2-7).

Mule deer critical winter range disturbance and human presence at the Big Mesa Camp would result in a mule deer population reduction of 11 mule deer for the 5-year construction camp life. Once the camp is dismantled and reclamation and revegetation are accomplished, the mule deer population

reduction would be expected to be 5 deer until critical range shrub habitats regenerate to adequate productivity levels in 15 years. Mule deer productivity losses during construction camp construction, operation, and abandonment would total 40 deer. Similarly, pronghorn critical winter range disturbance would reduce populations by 14 animals during construction and operation and 7 animals during abandonment. Total pronghorn productivity losses would be 86 animals. Disturbance to pronghorn critical summer range at the Shute Creek camp would not be expected to result in pronghorn population reductions or productivity losses.

Additionally, when construction camps are within or in close association to critical wildlife ranges, the potential for poaching or harassment would be increased by an unquantified amount. This impact may be partially compensated for by the associated decrease in workers commuting and concomitant reduction in vehicle-wildlife collisions.

BUCKHORN ALTERNATIVE

WELL FIELD

The impact of construction, operation, and abandonment of the well field as presented for the Proposed Action would also apply to all alternatives (Tables 2-2, 2-4, and 2-8).

PLANT SITES

Construction at the East Dry Basin, West Dry Basin, Buckhorn, and Craven Creek plant sites and sulfur loadout facility would remove 2,800 acres of wildlife habitat from production (Table 2-2). Critical ranges in these areas would be affected with the disturbance of 640 acres of mule deer critical winter range, 640 acres of pronghorn critical winter range, and 840 acres of pronghorn critical summer range (Table 2-8, Maps 1-1 through 1-5, see Map Pocket).

These critical range disturbances would result in a population reduction of 88 mule deer during plant site construction and operation. This reduction would cause a productivity loss of 919 deer for the 35-year plant life. After abandonment, the deer population reduction would drop to 44 with an additional productivity loss of 197. In a similar manner, pronghorn critical winter range disturbances would reduce the pronghorn population by 28 during construction and operation and 14 during abandonment, and cause productivity losses of 482 pronghorn during construction and operation and 103 during abandonment. The loss of pronghorn critical summer range cannot be reliably correlated to population reductions or productivity losses. Plant site construction would remove 191 acres of prairie dog towns, the same acreage as the Proposed Action.

Because plant sites would be located in roughly the same geographical areas as the Proposed Action, human population increases would also be expected to occur in the same towns and counties and in the same numbers. Thus, human disturbance impacts to wildlife (poaching, wanton killing, harassment) would also be expected to be similar to the Proposed Action, increasing, 66, 37, and 3 percent in Sublette, Lincoln, and Sweetwater Counties, respectively during peak construction (see EIS Socioeconomics Section). This would

TABLE 2-8

ACRES OF WILDLIFE CRITICAL RANGES DISTURBED BY THE BUCKHORN ALTERNATIVE

	Well Field	Plant Sites ¹	Corridors	Total
Elk Critical Winter Range	1,019	0	460	1,479
Elk Critical Calving Range	1,107	0	0	1,107
Mule Deer Critical Winter Range	142	640	1,797	2,579
Moose Critical Winter Range	287	0	160	447
Pronghorn Critical Winter Range	0	640	1,739	2,379
Pronghorn Critical Summer Range	0	840	1,057	1,897
Prairie Dog Towns	0	191	530	721

¹Includes Sulfur Loadout.

constitute a significant impact in both Sublette and Lincoln Counties (see Significance Criteria). The impacts of project-related traffic on wildlife would be the same as those presented for the Proposed Action.

LINEAR FACILITIES

The construction of roads, pipelines, transmission lines, and other linear facilities off the well field would disturb 6,215 acres of wildlife habitat or 48 percent of the total 12,983 disturbed acres in the Buckhorn Alternative (Table 2-2). Corridor disturbance to critical range would include 1,797 acres of mule deer critical winter range, 1,739 acres of pronghorn critical winter range, 1,057 acres of pronghorn critical summer range, 460 acres of elk critical winter range, and 160 acres of moose critical winter range (Table 2-8).

As in the Proposed Action, construction of these linear facilities would take place over several years so that not all of these acreages would be disturbed at any one time. Big game population reductions and productivity losses are not expected.

There would be 530 acres of prairie dog towns disturbed during corridor construction resulting in a significant impact as discussed under the Proposed Action.

Potential wildlife impacts from transmission lines would be similar to those discussed for the Proposed Action. The potential for bird wire-strike incidents would be relatively high where the transmission line crosses the Green River in the Buckhorn Alternative in addition to the sensitive areas of Fontenelle Creek and LaBarge Creek discussed for the Proposed Action.

A sour gas pipeline and sulfur pipeline crossing the Green River east of the well field would disturb riparian habitat, but significant impacts are not anticipated. All corridors in the Buckhorn Alternative would disturb 83 acres of riparian habitat for a short period assuming reclamation success in 3-5 years (see EIS Vegetation Section).

SHUTE CREEK ALTERNATIVE

WELL FIELD

The wildlife impacts of well field construction, operation, and abandonment would be the same as the Proposed Action for all alternatives (Tables 2-2, 2-4, and 2-9).

PLANT SITES

Construction at the Buckhorn, Shute Creek, and Craven Creek plant sites would remove 2,160 acres of wildlife habitat from production (Table 2-2). Exxon would consolidate two northern plant sites onto the one Shute Creek site. There would not be any big game critical winter range disturbances on any of the sites, therefore, no big game population reductions or productivity losses impacts would occur on the sites (Table 2-9). About 900 acres of pronghorn critical summer range would be removed, however, critical summer range designation is dependent on water availability and range

TABLE 2-9

ACRES OF WILDLIFE CRITICAL RANGES DISTURBED BY THE SHUTE CREEK ALTERNATIVE

	Well Field	Plant Sites ¹	Corridors	Total
Elk Critical Winter Range	1,019	0	666	1,685
Elk Critical Calving Range	1,107	0	0	1,107
Mule Deer Critical Winter Range	142	0	1,468	1,610
Moose Critical Winter Range	287	0	165	452
Pronghorn Critical Winter Range	0	0	1,342	1,342
Pronghorn Critical Summer Range	0	900	778	1,678
Prairie Dog Towns	0	163	901	1,064

¹Includes Sulfur Loadout.

reductions cannot be reliably correlated to population impacts. Plant site construction would remove 163 acres of prairie dog towns with impacts similar to those described for the Proposed Action.

The magnitude of human population increases and increases in human disturbance to wildlife would be similar to the Proposed Action, however, population distribution would be such that there would be 48 percent growth in Sublette County, 42 percent in Lincoln County, and 4 percent in Sweetwater County during peak construction (see EIS Socioeconomics Section). This represents a relatively uniform population spread. Increases in human disturbance to wildlife as poaching, wanton killing, and harassment would also be expected to increase in those proportions. Therefore, significant human disturbance impacts on wildlife would occur in Sublette and Lincoln Counties (see Significance Criteria).

Impacts of poaching, vehicle-wildlife collisions, and other human disturbance causes would continue through operation but gradually decrease as temporary construction workers are replaced with long-term oil company and contractor employees. By 1995, project-related population would decrease to 21, 16, and less than 1 percent over baseline in Sublette, Lincoln, and Sweetwater Counties, respectively (EIS Socioeconomics Section). Human disturbance impacts would decrease accordingly.

Vehicle-wildlife collision impacts from project-related traffic of the Shute Creek Alternative on Highway 189 between Big Piney and Fontenelle Reservoir would be 66 mule deer and 9 pronghorn per year during peak construction, a 53 percent increase over baseline. During operation, highway traffic and big game mortality would decrease to 10 mule deer and 2 pronghorn per year over baseline on this segment. Road kill data are unavailable for other highway segments within the project area, but this segment represents a high impact potential based on its relation to big game winter range.

As in the Proposed Action and Buckhorn Alternative, with increased traffic there is a proportionately increased chance of a vehicle striking a black-footed ferret should they inhabit the project area. Increased traffic and resulting road kills would also increase the chance of vehicles striking and killing wintering bald eagles and other raptors feeding on roadside carrion.

Access roads and worker traffic to and from the plant sites would pass through important wildlife areas. Shute Creek access may pass through potential black-footed ferret habitat, pronghorn critical winter range, and pronghorn critical summer range. Craven Creek access would pass through pronghorn critical summer range and potential black-footed ferret habitat. Buckhorn Site access would pass through pronghorn critical winter range and mule deer critical winter range (Maps 1-1 through 1-5, see Map Pocket).

Other impacts, including the potential effects of the 30-acre wastewater pond at the Craven Creek site, would be similar to the Proposed Action and Buckhorn Alternative.

LINEAR FACILITIES

The construction of roads, pipelines, transmission lines, and other linear facilities off the well field would disturb 5,987 acres of wildlife habitat or 49 percent of the total 12,115 disturbed acres in the Shute Creek

Alternative (Table 2-2). Corridor disturbance to critical range would include 1,468 acres of mule deer critical winter range, 1,342 acres of pronghorn critical winter range, 778 acres of pronghorn critical summer range, 666 acres of elk critical winter range, and 165 acres of moose critical winter range (Table 2-9).

As in the Proposed Action, construction of these linear facilities would take place over several years so that not all of these acreages would be disturbed at any one time. Big game population reductions and productivity losses are not expected. In this alternative, sales gas and CO₂ pipelines from the Shute Creek plant would cross approximately 2.5 miles of the Seedskaadee National Wildlife Refuge temporarily disrupting wildlife use and causing a short-term disturbance to riparian habitat.

There would be 901 acres of prairie dog towns disturbed during corridor construction resulting in a significant impact as discussed under the Proposed Action.

Potential wildlife impacts from transmission lines would be similar to those discussed for the Proposed Action. The potential for bird wire-strike incidents would be higher where the transmission line crosses the Green River in the Shute Creek Alternative in addition to the sensitive areas of Fontenelle Creek and LaBarge Creek discussed for the Proposed Action.

NORTHERN ALTERNATIVE

WELL FIELD

The wildlife impacts of well field construction, operation, and abandonment would be the same as the Proposed Action for all alternatives (Tables 2-2, 2-4, and 2-10).

PLANT SITES

The Northern Alternative would concentrate all four treatment plants on sites in the northern portion of the project area. These sites are West Dry Basin, East Dry Basin, Big Mesa, and Buckhorn, all of which were part of the Proposed Action or other alternatives. As the Northern Alternative, construction at these sites and the sulfur loadout facility would remove 2,800 acres of wildlife habitat from production (Table 2-2). Critical ranges within these sites would be affected with the long-term disturbance of 1,060 acres of mule deer critical winter range, 640 acres of pronghorn critical winter range, and 200 acres of pronghorn critical summer range (Table 2-10, Maps 1-1 through 1-5, see Map Pocket).

These critical range disturbances would result in a population reduction of 145 mule deer during plant site construction and operation. This reduction would cause a productivity loss of 1,523 deer for the 35-year plant life. After abandonment, the deer population reduction would drop to 76 with an additional productivity loss of 326. In a similar manner, pronghorn critical winter range disturbances would reduce the pronghorn population by 28 during construction and operation and 14 during abandonment, and cause productivity losses of 482 pronghorn during construction and operation and 103 during abandonment. The loss of pronghorn critical summer range cannot be reliably correlated to population reductions or productivity losses. Plant site construction would remove 123 acres of prairie dog towns, resulting in impacts similar to those described for the Proposed Action.

TABLE 2-10

ACRES OF WILDLIFE CRITICAL RANGES DISTURBED BY THE NORTHERN ALTERNATIVE

	Well Field	Plant Sites ¹	Corridors	Total
Elk Critical Winter Range	1,019	0	336	1,355
Elk Critical Calving Range	1,107	0	0	1,107
Mule Deer Critical Winter Range	142	1,060	1,818	3,020
Moose Critical Winter Range	287	0	308	595
Pronghorn Critical Winter Range	0	640	1,704	2,344
Pronghorn Critical Summer Range	0	200	935	1,135
Prairie Dog Towns	0	123	417	540

¹Includes Sulfur Loadout.

The magnitude of human population increases and increases in human disturbance to wildlife would be similar to the Proposed Action, however, human population distribution would be concentrated in the north (Sublette County) so that there would be an 89 percent growth in Sublette County, 28 percent in Lincoln County, and 2 percent in Sweetwater County during peak construction (see EIS Socioeconomics Section). Increases in human disturbance to wildlife as poaching, wanton killing, and harassment would also be expected to increase in those proportions. Therefore, significant human disturbance impacts on wildlife would occur in Sublette and Lincoln Counties (see Significance Criteria).

Impacts of poaching, vehicle-wildlife collisions, and other human disturbance causes would continue through operation but gradually decrease as temporary construction workers are replaced with long-term oil company and contractor employees. By 1995, project-related population would decrease to 41, 8, and less than 1 percent over baseline in Sublette, Lincoln, and Sweetwater Counties, respectively (EIS Socioeconomics Section). Human disturbance impacts would decrease accordingly.

Vehicle-wildlife collision impacts from project-related traffic of the Northern Alternative on Highway 189 between Big Piney and Fontenelle Reservoir would be 216 mule deer and 31 pronghorn per year during peak construction, a 173 percent increase over baseline. During operation, highway traffic and big game mortality would decrease to 41 mule deer and 6 pronghorn per year over baseline on this segment. Road kill data are unavailable for other highway segments within the project area but this segment represents a high impact potential based on its relation to big game winter range.

As in the Proposed Action, with increased traffic there is a proportionately increased chance of a vehicle striking a black-footed ferret should they inhabit the project area. Increased traffic and resulting road kills would also increase the chance of vehicles striking and killing wintering bald eagles and other raptors feeding on roadside carrion.

Access roads and worker traffic to and from the plant sites would pass through many categories of important wildlife areas (Maps 1-1 through 1-5, see Map Pocket) resulting in many road kills annually. Plant site access through critical ranges would also increase the opportunity of human disturbance impacts of poaching, wanton killing, and harassment. In this alternative, Northwest's plant at East Dry Basin would contain a toxic wastewater evaporation pond with potential impacts as discussed under the Proposed Action.

LINEAR FACILITIES

The construction of roads, pipelines, transmission lines, and other linear facilities would disturb 6,282 acres of wildlife habitat or 48 percent of the total 13,050 disturbed acres in the Northern Alternative (see Table 2-2). Corridor disturbance to critical range would include 1,818 acres of mule deer critical winter range, 1,704 acres of pronghorn critical winter range, 935 acres of pronghorn critical summer range, 336 acres of elk critical winter range, and 308 acres of moose critical winter range (Table 2-10).

As in the Proposed Action, construction of these linear facilities would take place over several years so that not all of these acreages would be disturbed at any one time. Big game population reductions and productivity losses are not expected.

There would be 417 acres of prairie dog towns disturbed during corridor construction resulting in a significant impact as discussed under the Proposed Action.

Potential wildlife impacts from transmission lines would be similar to those discussed for the Proposed Action. The potential for bird wire-strike incidents would be higher where the transmission line crosses the Green River in the Northern Alternative in addition to the sensitive areas of Fontenelle Creek and LaBarge Creek discussed for the Proposed Action.

LITERATURE REVIEW

A literature review was conducted to compile available information describing wildlife resources of the Riley Ridge Project Area. Biologists from the Wyoming Game and Fish Department (WGF), Forest Service (FS), Bureau of Land Management (BLM), and Fish and Wildlife Service (FWS) were interviewed for information pertinent to the region. Published literature and unpublished reports were collected to aid in description of the area. Table 3-1 presents a list of sources contacted for information.

SITE RECONNAISSANCE

A site reconnaissance was conducted by the wildlife discipline manager with biologists from WGF, FS, and BLM during late 1982 to gain familiarity with the wildlife habitats on the study area. Potential critical areas were studied including wetlands and riparian habitats, elk calving grounds, bighorn sheep critical habitat, and unique or sensitive areas.

DATA MANIPULATION AND ANALYSIS

Important wildlife observations from the WGF Wildlife Observation System were compiled from computer print-outs and plotted on a 0.5 inch = 1 mile BLM land status maps. Data on big game species, raptors, sage grouse, special status species, and threatened and endangered species were compiled to determine areas of high use or critical importance to local wildlife populations.

Forage/cover ratios were developed from existing information from Bridger-Teton National Forest and BLM Pinedale Resource Area. Applicants' development plan information was used to predict changes in the forage/cover ratios of the well field area.

The quality of elk summer habitat on the well field was evaluated using the FS method "Estimating Effects of Habitat Changes on Potential Elk Use in Western Wyoming." A copy of this methodology is included at the end of this chapter. This procedure was developed in the Blue Mountains of Oregon and Washington, Bridger-Teton National Forest, and elsewhere in the west and was specifically designed for impact analysis of timber sales. Adaptation of these methods to oil and gas development involved discussions with FS and BLM biologists (Hinschberger, Doughty, and Gordon 1982). Results of this method are expressed as the percent elk habitat effectiveness of an area. This value reflects the estimated use elk may make of an area, considering the amount and arrangement of cover and forage, the amount of human disturbance due to roads, and the availability of security cover for protection from human disturbance.

Elk habitat effectiveness was analyzed on three habitat units on FS land and three habitat units on BLM land. Because of the differences in quality of elk habitat between FS and BLM land, these two areas were analyzed slightly differently. The FS land computations adhered to the following procedures

TABLE 3-1

SOURCES CONTACTED FOR EXISTING INFORMATION ON WILDLIFE POPULATIONS
OF THE RILEY RIDGE PROJECT AREA

Wyoming Game and Fish Department

Cheyenne State Office

Dale Strickland

Harry Harju

Lee Wollrab

Lynn Mercier

Big Piney

Bruce Johnson

Chuck Thornton

Pinedale

Jim Straley

Smoot

Dave Lockman

Lander

Bob Oakleaf

Sam Fitton

- Herd unit data for game species
- Wildlife harvest reports
- Game violation information
- Endangered species information
 - known prairie dog towns
 - black-footed ferret sightings
 - Whooping crane sightings
 - Bald eagle wintering areas, roosts, perches, and nests
 - Peregrine falcon sightings
- Handbook of biological techniques
- Wildlife management strategic plan
- Wyoming avian atlas
- Raptor nesting information
- Non-game survey information
- Wildlife observation system data

Bridger-Teton National Forest

Big Piney Ranger District

Mark Hinschberger

Doug Turner

Jackson Supervisor's Office

John Weaver

Floyd Gordon

Kemmerer Ranger District

Conrad Franz

- Forest management plan
- Timber stand classification
- Cover/forage data
- Habitat maps
- Data summaries on forest management indicator species

Bureau of Land Management

Pinedale

Larry Doughty

- Unit resource analyses
- Management framework plan
- Habitat unit mapping
- Cover/forage data

TABLE 3-1 (CONTINUED)

U.S. Fish and Wildlife Service

Denver Regional Office
 Jerry Nugent
 Al Jenkins

- Endangered species records
- Sandhill crane staging areas
- National wildlife refuge data

Cheyenne Ecological Services Office
 Art Anderson

Seedskaadee National Wildlife Refuge
 Joe Rodriquez

Upper Green River Naturalists Club

Big Piney
 John Row

- Avian distribution information
-

designating as cover: conifer with crown density over 40 percent, 15 percent of aspen with significant conifer understory, and 25 percent of riparian habitats. All other areas are noncover (Hinschberger 1982, personal communication). Analysis of BLM land designated both conifer and aspen with crown density over 40 percent as cover, and any area with less than 40 percent crown cover as noncover (Doughty 1982, personal communication).

HABITAT MAPPING

Wildlife habitat maps of the study area were prepared using information collected from state and federal agencies and habitat information provided by vegetation and field studies. The habitat maps delineate important and critical wildlife habitat for big game, small game, raptors, and special status species. Information mapped for analysis, but not necessarily presented in the Technical Report includes:

- bald eagle wintering areas
- prairie dog towns
- sandhill crane observation locations
- whooping crane observation locations
- raptor nests
- sage grouse strutting grounds
- elk calving areas
- mule deer critical winter range
- elk critical winter range
- moose critical winter range
- elk feedground
- pronghorn critical winter range
- pronghorn critical summer range
- special status areas

PRAIRIE DOG TOWN MAPPING

A prairie dog town survey was conducted on the Riley Ridge study area October 14 to 20, 1982. All well field units and corridors outside the well field were plotted on either a USGS 7.5-minute quad or on a 7.5-minute ortho photo. These maps were used in the field to accurately plot the location and size of each prairie dog town.

This survey was conducted using a Hughes 500 helicopter with a pilot and two observers. The pilot and one observer followed quad sheets or ortho photos so that each well field unit or corridor was accurately surveyed. The second observer noted signs of prairie dogs and recorded notes on town size, vegetation type, and location. All towns found within the corridor were mapped completely, including those portions of the towns outside of corridor boundaries. The first observer plotted the location, size, and identification number of each town directly onto the quad or ortho photo.

The helicopter was flown along the well field and corridors approximately 75 to 100 feet above the ground at 40 to 60 miles per hour, depending on the terrain and habitat. When a prairie dog town or holes were observed, the helicopter circled the area to determine the approximate shape of the town and its associated vegetation. The town was circled until it could be accurately plotted on the quad or ortho photo. This procedure continued until all corridors were surveyed. All prairie dog towns located within the

well field, corridors, and support facilities were accurately plotted on a base map and the size of each town in acres was determined. Observations and other wildlife or raptor nest locations were also recorded.

IMPACT ANALYSIS

On-going sweet gas development and associated impacts were treated as part of baseline conditions as per BLM impact analysis instructions. Calculations to determine significance of impacts were adjusted to reflect sweet gas development within the well field between 1983 and 1990. The percentage of disturbance was not affected. For example, disturbance to elk critical winter range is a significant issue and an area that would represent the greatest effect by sweet gas development assumptions:

- Unadjusted: $\frac{1,019 \text{ acres of disturbance}}{55,000 \text{ acres of elk critical winter range}} = 1.9 \%$
- Adjusted: $\frac{1,019 \text{ acres of disturbance}}{54,660 \text{ acres of elk critical winter range}} = 1.9\%$

Big game impacts as a result of habitat disturbances of project development were estimated with the following assumptions:

- Critical winter range is the limiting range for big game populations. Therefore, losses to critical winter range would be expected to result in big game population reductions.
- The area of influence for well field critical habitat disturbances as a result of human activity would increase the effective habitat loss by a factor of:
 - 5 for elk
 - 5 for moose
 - 3 for deer
- The area of influence for plant site and other non-linear facilities critical habitat disturbances as a result of human activity would increase the effective habitat loss by a factor of:
 - 2 for deer
 - 2 for pronghorn
- Productivity losses would be calculated at a rate of:
 - 0.25/adult/year for elk
 - 0.25/adult/year for moose
 - 0.30/adult/year for deer
 - 0.50/adult/year for pronghorn
- Well field life is 40 years for all applicants (including application of increase factors)
- Critical habitat regeneration will take an additional 15 years (no increase factors applied)
- Treatment plants will operate for 35 years for all applicants

- Critical habitat losses as a result of off well field linear disturbances would decrease forage productivity for the short term, but would not result in big game population decreases or productivity losses
- Density of wintering elk in well field given:
400 elk wintering naturally
32,370 acres of elk critical winter range in well field
= 0.0124 elk/acre
- Density of wintering deer in Wyoming Range Herd Unit given:
32,000 deer in Herd Unit
467,840 acres of critical winter range in Herd Unit
= 0.0684 deer/acre
- Density of wintering moose in Sublette Herd Unit given:
1,335 moose in Herd Unit
312,000 acres of critical winter range in Herd Unit
= 0.0043 moose/acre
- Density of wintering pronghorn in Sublette Herd Unit given:
13,500 pronghorn in Herd Unit
626,560 acres of critical winter range in Herd Unit
= 0.0215 pronghorn/acre

Big game road kill estimates were calculated using transportation section traffic modeling estimates, known road kills, and estimates for 1981/1982 mortality, and the assumption that there is a direct linear relationship between the number of big game-vehicle collision kills and average daily traffic volume.

NESTING RAPTOR AND SAGE GROUSE STRUTTING GROUND FIELD SURVEY

Existing information on locations of raptor nests and sage grouse strutting grounds was collected from state and federal agencies and plotted on the wildlife habitat maps. To supplement existing data, ERT will conduct field studies during May 1983, a period when both activities are best observed. Surveys will complement and improve existing information. Sage grouse strutting ground surveys will be conducted in the early morning and concentrate on verifying and obtaining accurate counts of grouse on known strutting grounds and checking areas of favorable habitat for other strutting activity. Similarly, raptor nest locations will be examined to verify activity and collect information on certain parameters such as species use, number of young, degree of development, etc. All raptor nest locations will be plotted on USGS topographic maps. Data will include species, number, age, nest location, nest activity, production, and habitat description for all nests. All data will be cross-referenced with existing survey data.

Estimating Effects of Habitat Changes
on Potential Elk Use in
Western Wyoming - A Preliminary Procedure
for Project Review

BRIDGER-TETON NATIONAL FOREST
WILDLIFE MANAGEMENT

I. INTRODUCTION

Elk/logging coordination guidelines had been developed previously for the Bridger-Teton National Forest (1979) and surrounding lands. Based on a format developed in the Blue Mountains of Oregon and Washington by Black et al. (1976) and used elsewhere in the west, these guides described habitat components and management concerns. Although outlining the general steps necessary to estimate effects of habitat changes on existing and potential elk use, they did not provide a specific procedure for the quantitative assessment of proposed actions. Lyon's (1980) review of the Montana Cooperative Elk-Logging Study emphasized the point that elk habitat cannot be evaluated in separate parts, but that all components must be simultaneously considered.

The following procedure was developed to facilitate the assessment of present and proposed land management practices on elk and their habitat and to provide a standard means of evaluation and data display. The procedure provides the land manager with a logical method of organizing major factors effecting elk populations, displays cause and effect relationships, aids the decision making process and allows objective post-sale evaluations. Final adjustments of timber sale layout/design will require field reconnaissance by a wildlife biologist.

II. EVALUATION PROCEDURE

The procedure was based upon past studies and literature reviews of elk/logging management in the west. It is based in part on, and is to be used in conjunction with, the Bridger-Teton Elk/Logging Coordination Guidelines. It appears to have potential for application in oil and gas exploration and land development projects.

At this time, the evaluation procedure is limited to an assessment of cover/noncover arrangement, road effects, and suitability of security cover within and adjacent to a sale area. Livestock grazing, although recognized as having potential effect on elk, is not considered here but should be included in any update of the evaluation procedure.

This evaluation procedure was designed, for application in western Wyoming. It is recognized, however, the assumptions and process can undoubtedly be refined during future application by wildlife biologists associated with State and Federal agencies. It should be stressed, that to be workable, incorporation of ideas from other resource functions and the public is essential.

A. Parameters for Predicting Elk Responses to Habitat Change and Disturbance1. Cover/Noncover Arrangement

Most elk/logging coordination guidelines describe ratios of cover to noncover that are seasonally important to elk. Maximum elk use is assumed to occur when a given percent of the area is in cover. A cover/noncover ratio, however, does not provide a complete picture of the area's value as elk habitat. Areas with similar cover/forage ratios do have varying arrangements of forested and non-forested vegetation which significantly affect their value as elk habitat.

a. Assumptions

- (1) Optimum habitat is the amount and arrangement of cover and noncover areas that result in the maximum possible use of the maximum possible area by elk.
- (2) The amount of effective habitat available (cover and noncover areas that are used to their optimum potential) during the period July 15 to November 1 determines maximum elk use. (i.e. security or hiding cover use is greatest in this time period.)
- (3) During the period July 15 to November 1, cover (vegetation functioning as hiding and thermal cover) is usually limited to that provided by coniferous stands of timber. In some situations deciduous trees and shrubs may be used. (i.e. available conifer cover is more effective in promoting herd stability in the late summer/fall hunt period when cover is most limiting.)
- (4) Due to the current mature condition of forested stands, stands that function as thermal cover may serve as hiding cover.
- (5) The cover requirement and/or need is no greater in the pre-hunt period than during the hunt period.

b. Characteristics of Cover and Noncover

- (1) Coniferous timber stands having a crown closure of 40 percent or greater are considered to represent cover. (See Appendix, Table 1, for cover criteria by timber stand stratification).
- (2) Patches of conifers in riparian areas and aspen stands may qualify as cover. For example, 25 percent of the riparian areas and 15 percent of the aspen

stands are judged (photo-review) to contain enough conifers to qualify as cover. (See Appendix, Table 1).

- (3) Coniferous timber stands having a crown closure of less than 40 percent, non-forested areas and riparian areas and aspen stands not included in cover, are considered to represent potential forage sites (See Appendix, Table 1).

c. Characteristics of Effective Habitat

Cover

Effective cover occurs when cover components are arranged in a manner that allows optimum use by elk. The following describes the parameters of effective cover.

- (1) Individual cover patches are between 26 to 60 acres in size and 1,200 to 1,800 feet in width and length.
- (2) Cover patches are arranged so that movement between patches is facilitated, i.e., patches connected by corridors of cover.
- (3) Some noncover may be present.

An exception involves narrow forested stringers (timbered islands) 1,200 to 1,800 feet in width that are surrounded by noncover. In such situations, length can exceed 1,800 feet and stand size can exceed 60 acres and still maintain optimum cover characteristics. Breaking up these forest stands into 26 to 60 acre cover patches may disrupt elk use.

Forage

Optimum arrangement of forest openings around cover permits maximum possible use of the maximum area by elk. The following describes optimum arrangement of foraging areas.

- (1) Forage areas should have no point farther than 600 feet from the edge of cover.
- (2) Distance between cover areas should not exceed 1,200 feet.

2. Road Effects

Frequent human activity can cause displacement of elk to more secure habitat. Roads are the means by which most human disturbance occurs on elk ranges.

a. Assumptions

- (1) Roads closed to motorized vehicles are considered to have a negligible effect on elk.
- (2) Closed roads are assumed to have 100 percent effective closures.
- (3) Heavily traveled (secondary) roads are considered to have a greater potential for elk displacement than lightly traveled (primitive) roads.
- (4) The amount of habitat affected by an open road is dependent upon whether the road passes through cover or noncover. Less elk displacement is expected within cover habitats than within more open foraging habitat.

b. Characteristics of Roads and Their Effect on Elk Use

- (1) Roads are classified as being secondary (system) or primitive (jeep trails).
- (2) Roads are classified as being closed or open to motorized vehicles.
- (3) Open roads can effect habitat use by elk up to .9 miles (Lyon 1979) from each side of the road center line.

3. Security Cover

Security cover is habitat that, because of its size, topography, and vegetative pattern, is capable of holding elk which have been displaced from their usual range by human activity.

a. Assumption

During periods of disturbance, elk respond by moving to more secure habitat.

b. Characteristics of Security Cover

Security cover is considered to be:

- (1) An area greater than 5,000 acres in size, composed of individual cover patches 26-60 acres in size.
- (2) Out of line of sight from area of human activity.
- (3) Inaccessible to motorized vehicles during anticipated period of use.

B. Computing Effects of Proposed Activity on Potential Elk Use

1. Assessment Areas

Evaluation of the proposed activity's effect on elk begins with delineating an assessment area on an orthoquad. The assessment should include the proposed area (i.e. timber sale area) and surrounding lands that are likely to be impacted.

It is recommended that the assessment area under consideration be a Habitat Unit or combination of Habitat Units subdivided into logical groupings of approximately 6,000 to 12,000 acre Subunits. The Subunits are the units of land on which the actual evaluations are carried out. Subunits are equivalent to Diversity Units as used in the Forest Planning Process.

It should be noted that Subunits less than 6,000 acres are generally not large enough to adequately display the offsite effects of a proposed project. Conversely, Subunits that are excessively large tend to dilute the effect of a project. The results from all Subunits are tallied to display effects of proposed activity on elk use within the assessment area. Boundaries of Subunits should coincide with timber compartments and stand boundaries for easy retrieval of information from timber stand stratification data.

2. Data Base Preparation

After a base orthoquad map is prepared, timber compartment maps and the criteria in Table 1 of the Appendix are used to prepare overlays which differentiate cover from forage components. Additional overlays are prepared which display the location of existing and proposed system roads; primitive roads as well as road disturbance zones; effective cover and forage habitat; security cover areas; and proposed harvest units by Subunit. These maps and associated acreage data then become the basis for analysis.

3. Data Needed for Pre-Sale and Post-Sale Calculations

To estimate effects of habitat change on potential elk use, the following information is required. Computation forms have been provided for recording the information by Subunit.

a. Computation Form No. 1, Appendix

Acres of Cover and Noncover Per Subunit As Determined From Timber Stand Stratification Data. (See Table 1)

(1) Total acres within each Subunit.

(2) Total non-use acres within each Subunit (rivers, ponds, riparian zone, etc.).

- (3) Total acres in cover and noncover (includes forage areas) within each Subunit. Cover and noncover components acres will be needed for pre and post-sale evaluation.

b. Computation Form No. 3, Appendix

Pre and Post-Sale Effects on Maximum Potential Elk Use Due to Open Roads.

- (1) Miles of secondary roads by Subunit open to vehicular traffic that pass through dense forest (cover), open forest and clearings (noncover).
- (2) Miles of primitive roads by Subunit that are open to vehicular traffic that pass through dense forest (cover), and open forest and clearings (foraging).
- (3) Total usable acres in Subunits more than 0.9 miles from centerline of open roads. Usable acres determined by delineating usable areas not affected by open roads on a clear map overlay.

4. Estimating Effects of Habitat Change on Potential Elk Use

Estimating effects of habitat changes on potential elk use is computed on the forms in the Appendix. These forms have been designed to provide the user with a step by step process of evaluation. Calculations are first made for existing pre-sale conditions and then post-sale conditions.

IV. LITERATURE CITED

Anonymous, 1979. Application of existing knowledge for protection of big game habitat in timber sale design, layout and administration. Bridger-Teton National Forest.

Black, H. R. J. Scherzinger and J. W. Thomas, 1976. Relationships of Rocky Mountain elk and Rocky Mountain mule deer to timber management in the Blue Mountains of Oregon and Washington. IN proceedings: Elk-Logging-Roads Symposium. Univ. of Idaho, Moscow.

Lyon, L. J., 1979. Habitat effectiveness for elk as influenced by roads and cover. J. For. Vol. 77.

, 1980. Coordinating Forestry and Elk management. Trans. N. Amer. Wildl. and Natur. Resour. Conf. 45.

TABLE 1. List of the 100 most important plant species in the study area

Rank	Species	Family	Number of specimens
1	<i>Pinus sylvestris</i>	Pinaceae	100
2	<i>Quercus robur</i>	Fagaceae	95
3	<i>Salix caprea</i>	Salicaceae	90
4	<i>Betula pubescens</i>	Betulaceae	85
5	<i>Alnus glutinosa</i>	Fagaceae	80
6	<i>Ulmus glabra</i>	Ulmaceae	75
7	<i>Fraxinus excelsior</i>	Fagaceae	70
8	<i>Corylus avellana</i>	Fagaceae	65
9	<i>Castanea sativa</i>	Fagaceae	60
10	<i>Liriodendron tulipifera</i>	Guttiferaceae	55
11	<i>Thuja occidentalis</i>	Coniferae	50
12	<i>Juniperus communis</i>	Coniferae	45
13	<i>Abies balsamea</i>	Coniferae	40
14	<i>Podocarpus nagi</i>	Podocarpaceae	35
15	<i>Taxus canadensis</i>	Coniferae	30
16	<i>Juniperus horizontalis</i>	Coniferae	25
17	<i>Thuja occidentalis</i>	Coniferae	20
18	<i>Juniperus communis</i>	Coniferae	15
19	<i>Abies balsamea</i>	Coniferae	10
20	<i>Podocarpus nagi</i>	Podocarpaceae	5
21	<i>Taxus canadensis</i>	Coniferae	4
22	<i>Juniperus horizontalis</i>	Coniferae	3
23	<i>Thuja occidentalis</i>	Coniferae	2
24	<i>Juniperus communis</i>	Coniferae	1
25	<i>Abies balsamea</i>	Coniferae	1
26	<i>Podocarpus nagi</i>	Podocarpaceae	1
27	<i>Taxus canadensis</i>	Coniferae	1
28	<i>Juniperus horizontalis</i>	Coniferae	1
29	<i>Thuja occidentalis</i>	Coniferae	1
30	<i>Juniperus communis</i>	Coniferae	1
31	<i>Abies balsamea</i>	Coniferae	1
32	<i>Podocarpus nagi</i>	Podocarpaceae	1
33	<i>Taxus canadensis</i>	Coniferae	1
34	<i>Juniperus horizontalis</i>	Coniferae	1
35	<i>Thuja occidentalis</i>	Coniferae	1
36	<i>Juniperus communis</i>	Coniferae	1
37	<i>Abies balsamea</i>	Coniferae	1
38	<i>Podocarpus nagi</i>	Podocarpaceae	1
39	<i>Taxus canadensis</i>	Coniferae	1
40	<i>Juniperus horizontalis</i>	Coniferae	1
41	<i>Thuja occidentalis</i>	Coniferae	1
42	<i>Juniperus communis</i>	Coniferae	1
43	<i>Abies balsamea</i>	Coniferae	1
44	<i>Podocarpus nagi</i>	Podocarpaceae	1
45	<i>Taxus canadensis</i>	Coniferae	1
46	<i>Juniperus horizontalis</i>	Coniferae	1
47	<i>Thuja occidentalis</i>	Coniferae	1
48	<i>Juniperus communis</i>	Coniferae	1
49	<i>Abies balsamea</i>	Coniferae	1
50	<i>Podocarpus nagi</i>	Podocarpaceae	1
51	<i>Taxus canadensis</i>	Coniferae	1
52	<i>Juniperus horizontalis</i>	Coniferae	1
53	<i>Thuja occidentalis</i>	Coniferae	1
54	<i>Juniperus communis</i>	Coniferae	1
55	<i>Abies balsamea</i>	Coniferae	1
56	<i>Podocarpus nagi</i>	Podocarpaceae	1
57	<i>Taxus canadensis</i>	Coniferae	1
58	<i>Juniperus horizontalis</i>	Coniferae	1
59	<i>Thuja occidentalis</i>	Coniferae	1
60	<i>Juniperus communis</i>	Coniferae	1
61	<i>Abies balsamea</i>	Coniferae	1
62	<i>Podocarpus nagi</i>	Podocarpaceae	1
63	<i>Taxus canadensis</i>	Coniferae	1
64	<i>Juniperus horizontalis</i>	Coniferae	1
65	<i>Thuja occidentalis</i>	Coniferae	1
66	<i>Juniperus communis</i>	Coniferae	1
67	<i>Abies balsamea</i>	Coniferae	1
68	<i>Podocarpus nagi</i>	Podocarpaceae	1
69	<i>Taxus canadensis</i>	Coniferae	1
70	<i>Juniperus horizontalis</i>	Coniferae	1
71	<i>Thuja occidentalis</i>	Coniferae	1
72	<i>Juniperus communis</i>	Coniferae	1
73	<i>Abies balsamea</i>	Coniferae	1
74	<i>Podocarpus nagi</i>	Podocarpaceae	1
75	<i>Taxus canadensis</i>	Coniferae	1
76	<i>Juniperus horizontalis</i>	Coniferae	1
77	<i>Thuja occidentalis</i>	Coniferae	1
78	<i>Juniperus communis</i>	Coniferae	1
79	<i>Abies balsamea</i>	Coniferae	1
80	<i>Podocarpus nagi</i>	Podocarpaceae	1
81	<i>Taxus canadensis</i>	Coniferae	1
82	<i>Juniperus horizontalis</i>	Coniferae	1
83	<i>Thuja occidentalis</i>	Coniferae	1
84	<i>Juniperus communis</i>	Coniferae	1
85	<i>Abies balsamea</i>	Coniferae	1
86	<i>Podocarpus nagi</i>	Podocarpaceae	1
87	<i>Taxus canadensis</i>	Coniferae	1
88	<i>Juniperus horizontalis</i>	Coniferae	1
89	<i>Thuja occidentalis</i>	Coniferae	1
90	<i>Juniperus communis</i>	Coniferae	1
91	<i>Abies balsamea</i>	Coniferae	1
92	<i>Podocarpus nagi</i>	Podocarpaceae	1
93	<i>Taxus canadensis</i>	Coniferae	1
94	<i>Juniperus horizontalis</i>	Coniferae	1
95	<i>Thuja occidentalis</i>	Coniferae	1
96	<i>Juniperus communis</i>	Coniferae	1
97	<i>Abies balsamea</i>	Coniferae	1
98	<i>Podocarpus nagi</i>	Podocarpaceae	1
99	<i>Taxus canadensis</i>	Coniferae	1
100	<i>Juniperus horizontalis</i>	Coniferae	1



TABLE 1. Habitat Function By Timber Stand Stratification Working Groups.^{1/}

Working Group	Group Codes	Description	Habitat ^{2/} Function
1		<u>Lodgepole pine, limber pine, whitebark pine</u>	
	11	Crown Density 0-25%	Noncover
	12	Crown Density 25-40%	Noncover
	13	Crown Density 40-70%	Cover
	14	Crown Density 70-100%	Cover
2		<u>Engelmann spruce, subalpine fir</u>	
	21	Crown Density 0-25%	Noncover
	22	Crown Density 25-40%	Noncover
	23	Crown Density 40-70%	Cover
	24	Crown Density 70-100%	Cover
3		<u>Douglas-fir</u>	
	31	Crown Density 0-20%	Noncover
	32	Crown Density 20-35%	Noncover
	33	Crown Density 35-70%	Cover
	34	Crown Density 70-100%	Cover
4		<u>Aspen</u>	
	41	Aspen stands with significant understory (15% or greater) of conifer	Noncover
	42	Aspen stands with little or no conifer understory	Noncover
	43	Aspen stands with significant conifer dominants (15% of stand contains conifers with a crown density greater than 40%).	Noncover

TABLE 1. (con't.)

Working Group	Group Codes	Description	Habitat ^{2/} Function
5		<u>Deforested - Partial Removal</u>	
	51	Deforested Areas which have been harvested or burned. May or may not have regeneration visible on photo. Includes clearcuts.	Noncover
	52	Partial Removal Areas which have had timber harvest activities that are easily discerned by photo interpretation. These are all cutting units, except clearcuts.	Noncover
6	61	<u>Non-Forested</u> Land that has never supported forests and lands formerly forested. Their use for timber management is precluded by development for other uses.	Noncover
7	71	<u>Non-Commercial - All Species</u> Sites ³ which are incapable of producing 20 ft ³ /acre/year or more. These sites will primarily be coded as 11, 21, 31, 41.	Noncover
8	81	<u>Census Water</u> Water surface areas larger than 40 acres or greater than 120 feet in width.	Noncover

TABLE 1. (con't.)

Working Group	Group Codes	Description	Habitat ^{2/} Function
9		<u>Non-Census Water</u>	
		Water surfaces and areas which are usually inundated some part of the year. Areas are between one and 40 acres, or rivers less than 120 feet in width.	
	91	Rivers	Noncover
	92	Ponds	Noncover
	93	Riparian Zone (25% of zone contains conifers with a crown density greater than 40%).	Noncover

^{1/}Information on acreage is available from Timber.

^{2/}Habitat function of timber stands should be field checked at the project level.

TABLE 2. Percent Decrease In Potential Elk Use As Related To Size And Inter-
persion Of Foraging Areas Within A Cover Group.

- A. 91-100 percent of foraging areas are within 600' of effective cover:
No decrease.
 - B. 51-90 percent of foraging areas are within 600' of effective cover:
0-5% decrease.
 - C. 0-50 percent of foraging areas are within 600' of effective cover:
6-10% decrease.
-

TABLE 3. Percent Decrease In Potential Elk Use As Related To Adequacy Of Available Security Cover.

Optimum Security Cover

1. Two or more security areas adjacent to activity area.
2. Each security area $\geq 5,000$ acre.
3. Inaccessible to motorized vehicles. No decrease.

Marginal Security Cover

1. One or more security areas adjacent to activity area.
2. Security area $\geq 5,000$ acres.
3. Inaccessible to motorized vehicles. 0-25% decrease.

Inadequate Security Cover

1. Security area $< 5,000$ acres.
 2. Security area $> 5,000$ acres accessible to motorized vehicle. 25-50% decrease.
-

COMPUTATION FORM 1. Total Acres And Acres Of Cover And Noncover Per Subunit As
Determined From Timber Stand Stratification Data.

Habitat Unit No. _____

Subunit No. _____

Working Group Codes (From Table 1)	Total Acres in Subunit	Acres of Cover ^{1/}	Percent of Total Subunit	Acres of Noncover	Percent of Total Subunit
11	_____	_____	_____	_____	_____
12	_____	_____	_____	_____	_____
13	_____	_____	_____	_____	_____
14	_____	_____	_____	_____	_____
21	_____	_____	_____	_____	_____
22	_____	_____	_____	_____	_____
23	_____	_____	_____	_____	_____
24	_____	_____	_____	_____	_____
31	_____	_____	_____	_____	_____
32	_____	_____	_____	_____	_____
33	_____	_____	_____	_____	_____
34	_____	_____	_____	_____	_____
42 ^{2/}	_____	_____	_____	_____	_____
43 ^{2/}	_____	_____	_____	_____	_____
51	_____	_____	_____	_____	_____
52	_____	_____	_____	_____	_____
61	_____	_____	_____	_____	_____
81	_____	_____	_____	_____	_____
93 ^{3/}	_____	_____	_____	_____	_____
TOTAL	_____	_____	_____	_____	_____

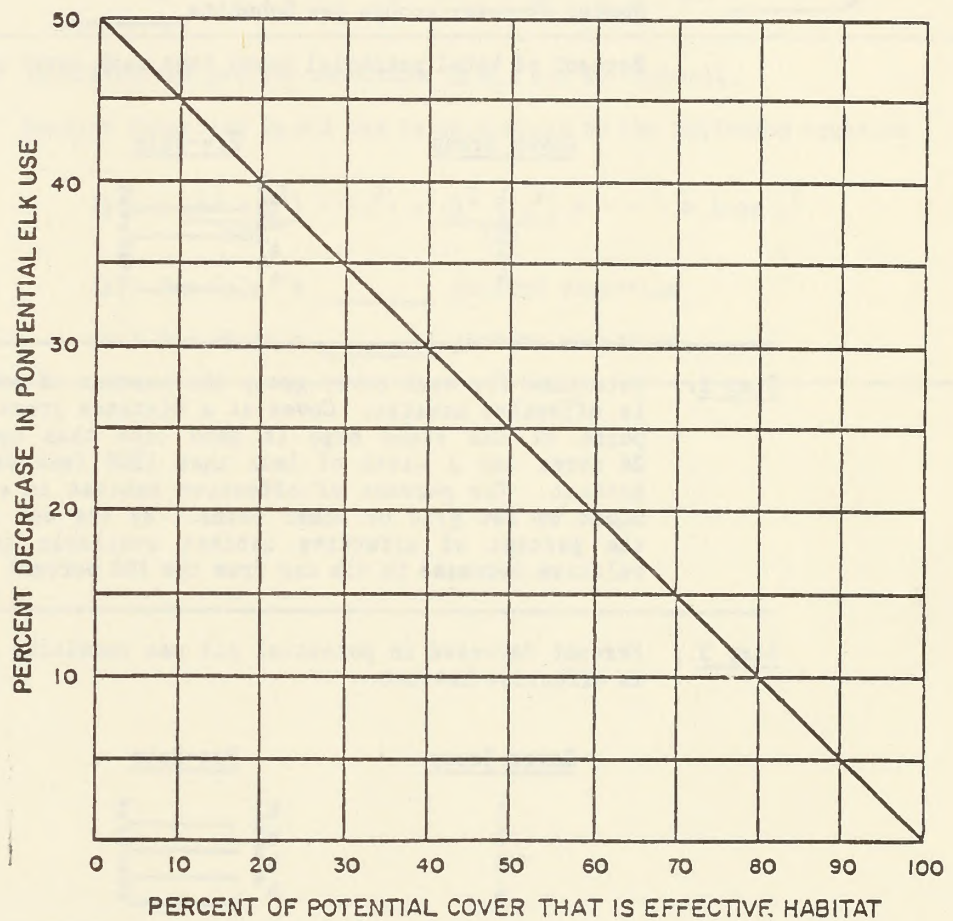
^{1/} Crown Density greater than 40 percent.

^{2/} 15 percent of stand has a Crown Density greater than 40 percent.

^{3/} 25 percent of stand has a Crown Density greater than 40 percent.

Figure 1.

PERCENT DECREASE IN POTENTIAL ELK USE
AS RELATED TO PERCENT OF POTENTIAL FORESTED
COVER THAT IS EFFECTIVE HABITAT



COMPUTATION FORM 2. Computing Pre-Sale/Post-Sale Effects On Maximum Potential Elk Use Due To Alteration In Habitat Effectiveness (Cover/Noncover Arrangement).

Pre-Sale _____
Habitat Unit _____

Post-Sale _____
Subunit _____

Step 1. Delineate on an orthoquad map overlay, cover groups within each Subunit that will be evaluated for cover effectiveness. Timber stands Greater than 1,200 feet apart will be evaluated separately.

Number of cover groups per Subunits _____

Percent of total potential cover that each cover group represents:

Cover Group	Pre-Sale	Post-Sale
1	a ¹ _____ %	a ¹ _____ %
2	a ² _____ %	a ² _____ %
3	a ³ _____ %	a ³ _____ %
4	a ⁴ _____ %	a ⁴ _____ %

Step 2. Determine for each cover group the percent of potential forest cover that is effective habitat. Cover at a distance greater than 900 feet from any point of the stand edge is used less than optimum. Stands less than 26 acres and a width of less than 1200 feet do not represent effective habitat. The percent of effective habitat in each cover group is determined by dot grid or other means. By the use of the graph in Figure 1, the percent of effective habitat available is used to determine the relative decrease in elk use from the 100 percent level.

Step 3. Percent decrease in potential elk use resulting from change in cover that is effective habitat.

Cover Group	Pre-Sale	Post-Sale
1	b ¹ _____ %	b ¹ _____ %
2	b ² _____ %	b ² _____ %
3	b ³ _____ %	b ³ _____ %
4	b ⁴ _____ %	b ⁴ _____ %

COMPUTATION FORM 2 (con't.).

Step 4. Determine the percent reduction in potential elk use as related to size and interspersions of foraging areas within a cover group (Table 2).

<u>Cover Group</u>	<u>Pre-Sale</u>	<u>Post-Sale</u>
1	1 _____ %	1 _____ %
2	c2 _____ %	c2 _____ %
3	c3 _____ %	c3 _____ %
4	c4 _____ %	c4 _____ %

Step 5. Determine the percent reduction in elk use for Subunit.

Percent reduction in elk use is determined by the following equation:

$$(a^1) \times \frac{(b^1 + c^1)}{100} + (a^2) \times \frac{(b^2 + c^2)}{100} + \dots = A \text{ or } A^1$$

(A) Pre-Sale = _____ percent reduction

(A¹) Post-Sale = _____ percent reduction

COMPUTATION FORM 3. Computing Pre-Sale/Post-Sale Effects On Maximum Potential Elk
Use Due To The Effect Of Roads Open To Motorized Vehicles.

Pre-Sale _____
Habitat Unit _____

Post-Sale _____
Subunit _____

Open Secondary Roads (System and Temporary)

Step 1. Determine miles of open secondary road through dense forest, open forest,
and clearings within Subunit.

Miles through dense forest (cover)
_____ (a¹)

Miles through open forest and clearings (noncover)
_____ (b¹)

Step 2. Total Acres affected by open secondary road.

In dense forest, miles of open roads _____ (a¹) x 1.8 miles* x 640 acres/sq.
mile = _____ (c¹) acres affected.

In open forest and clearings, miles of open roads _____ (b¹) x 1.8 miles* x 640
acres/sq. mile = _____ (d¹) acres affected.

Total acres affected by secondary roads. (c¹) + (d¹) = _____ (e¹).

*Elk use for .9 miles on either side of a road is affected by disturbance on the
road (Lyon 1967). The Gros Ventre Elk/Logging study results suggest a disturbance
zone of .5 miles on either side of road (April 29, 1981).

Open Primitive Roads (Jeep Trails)

Step 3. Determine miles of open primitive road through dense forest, open forest,
and clearings within Subunit.

Miles through dense forest (cover)
_____ (a²)

Miles through open forest and clearings (noncover)
_____ (b²)

COMPUTATION FORM 3 (con't).

Step 4. Total acres affected by open primitive roads.

In dense forest, miles of open roads _____ (a^2) x 1.8 miles* x 640 acres/sq. mile = _____ (c^2) acres affected.

In open forest and clearings, miles of open roads _____ (b^2) x 1.8 miles* x 640 acres/sq. mile = _____ (d^2) acres affected.

Total acres affected by primitive roads. (c^2) + (d^2) = _____ (e^2).

Step 5. Total acres affected by all open roads (e^1) + (e^2) = _____ (f).

Step 6. Total usable acres in Subunit more than .9 miles from roads, as determined by delineating areas away from road disturbance zone (g) within Subunit.

Step 7. Actual acres affected by roads within Subunit considering road overlap.

Acres in Subunit, Computation Form 1 _____ - (g) = _____ (h).

Step 8. Road density factor for area within .9 miles of road.

Actual acres affected (h) ÷ Total acres affected (f) = _____ (i).

Step 9. Actual acres affected by open secondary roads in Subunit.

Mile^{1/} of open roads in dense forest (c^1) x (i) = _____ (j^1) actual acres affected.

Miles^{1/} of open roads in open forest and clearings (d^1) x (i) = _____ (k^1) actual areas affected.

Step 10. Determine reduction in habitat effectiveness due to open secondary roads.

Acres usable at 100 percent in dense forest. Actual acres affected (j^1) x effective habitat coefficient .72 x road density factor^{2/}(i) = _____ (l^1) acres usable at 100 percent.

Acres usable at 100 percent in open forest and clearings. Actual acres affected (k^1) x effective habitat coefficient .69 x road density factor^{2/}(i) = _____ (m^1) acres usable at 100 percent.

Total acres in road disturbance zone usable at 100 percent. (l^1) + (m^1) = _____ (n^1).

^{1/}"Miles" should read "acres".

^{2/}"x road density factor (i)" should be deleted.
(Hinschberger 1982)

COMPUTATION FORM 3 (con't).

Open Primitive Roads

Step 11. Actual acres affected by open primitive roads in Subunit.

Miles^{1/} of open roads in dense forest (c^2) x (i) = _____ (j^2) actual acres affected.

Miles^{1/} of open roads in open forest and clearings (d^2) x (i) = _____ (k^2) actual acres affected.

Step 12. Reduction in habitat effectiveness due to open primitive roads.

Acres usable at 100 percent in open forest and clearings. Actual acres affected (j^2) x effective habitat coefficient .72 x road density factor^{2/}(i) = _____ (l^2) acres usable at 100 percent.

Acres usable at 100 percent in open forest and clearings. Actual acres affected (k^2) x effective habitat coefficient .69 x road density factor^{2/}(i) = _____ (m^2) acres usable at 100 percent.

Total acres in road disturbance zone usable at 100 percent. (l^2) + (m^2) = _____ (n^2).

^{1/}"Miles" should read "acres".

^{2/}"x road density factor (i)" should be deleted.
(Hinschberger 1982)

COMPUTATION FORM 4. Pre-Sale Or Post-Sale Summary Of Road Effects On Maximum Potential Elk Use.

Pre-Sale _____
Habitat Unit _____

Post-Sale _____
Subunit _____

Step 13. Total acres within road disturbance zone usable at 100 percent.

From Form No. 2.

Total usable acres in secondary road disturbance zone (n^1) + total usable acres in primitive road disturbance zone (n^2) = _____ (o) total acres within road disturbance zone usable at 100 percent.

Step 14. Total acres within Subunit usable at 100 percent.

(o) + (g)* = _____ (p) total acres within Subunit usable at 100 percent.
*Step 6.

Step 15. Percent of Subunit usable at 100 percent.

Total acres within Subunit usable at 100 percent (p) ÷ total acres within Subunit
_____ = _____ (q) percent of Subunit usable at 100 percent.

Step 16. Percent reduction in maximum potential elk use in Subunit because of road influences.

100 percent - percent of Subunit usable at 100 percent (q) = _____ percent
reduction in maximum potential elk use (B).

COMPUTATION FORM 5. Computing Pre-Sale/Post-Sale Adequacy Of Security Cover Around Activity Areas.

Habitat Unit _____

Subunit _____

Step 1. Determine adequacy of security cover around activity areas ie. timber harvest. Adequacy is determined by evaluating the quality and distribution of security cover in that Subunit in which the activity will occur (Table 3).

Reduction in potential elk use within Subunit due to inadequate security cover. _____(C)

COMPUTATION FORM 6. Summary Of Predicted Changes In Maximum Potential Elk Use
(Pre-Sale And Post-Sale) Within A Subunit.

<u>Pre-Sale</u>	<u>Percent</u>
Maximum potential elk use of Subunit	<u>100</u>
Reduction due to suboptimal cover(A)	____(from form 2)
Reduction due to road disturbance (B)	____(from form 4)
Reduction due to inadequacy of security cover(C)	____(from form 5)
POTENTIAL ELK USE BEFORE PROPOSED SALE	
(100) - (A) - (B) - (C)	____(I)
<u>Active Sale</u>	<u>Percent</u>
Maximum potential elk use of Subunit	<u>100</u>
Reduction due to suboptimal cover (A ¹)	____(from form 2)
Reduction due to road disturbance (B ¹)	____(from form 4)
Reduction due to inadequacy of security cover (C ¹)	____(from form 5)
POTENTIAL ELK USE DURING PROPOSED SALE	
(100) - (A ¹) - (B ¹) - (C ¹)	____(II)
<u>Post-Sale</u>	<u>Percent</u>
Maximum potential elk use of Subunit	<u>100</u>
Reduction due to suboptimal cover (A ²)	____(from form 2)
Reduction due to road disturbance (B ²)	____(from form 4)
Reduction due to inadequacy of security cover (C ²)	____(from form 5)
POTENTIAL ELK USE AFTER PROPOSED SALE	
(100) - (A ²) - (B ²) - (C ²)	____(III)

COMPUTATION FORM 6 (con't.).

Change in potential elk use between pre- and active sale

(I) - (II) = _____

Total change in potential elk use

(I) - (III) = _____

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APPENDIX A

APPENDIX A

- 1. General Design Information
- 2. Site Data, including Topography
- 3. Foundation Data
- 4. Soil Data
- 5. Material Properties
- 6. Structural Design Data

APPENDIX B

- 1. General Design Information
- 2. Site Data, including Topography
- 3. Foundation Data
- 4. Soil Data
- 5. Material Properties
- 6. Structural Design Data
- 7. Foundation Design Data
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- 6. Structural Design Data
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RILEY RIDGE PROJECT FACILITIES

DEFINITIONS

AQ	American Quasar Petroleum Company
W	Williams Exploration Company
Ex	Exxon Company, USA
M	Mobil Oil Corporation
NWP	Northwest Pipeline Corporation
NPP	Naughton Power Plant

WELL FIELD UNITS (same for proposed action and alternatives)

DMU	Proposed Darby Mt. Unit (AQ)
NRRU	Proposed North Riley Ridge Unit (AQ)
RRU	Riley Ridge Unit (AQ)
SA	Sawmill Area (W)
LRU	Lake Ridge Unit (Ex)
FCU	Fogarty Creek Unit (Ex)
GU	Graphite Unit (Ex)
DPU	Dry Piney Unit (inc. Dry Piney Annex) (Ex)
TTU	Tip Top Unit (M)
HU	Hogsback Unit (M)

PROPOSED ACTION

Non-Linear Facilities

EDB-AQ	East Dry Basin Plant Site (AQ)
WDB	West Dry Basin Plant Site (Ex)
BM	Big Mesa Plant Site (Ex)
CC	Craven Creek Plant Site (NWP)
SL	Sulfur Loadout (Ex)

Linear Facilities

RR-CC	- Railroad spur to Craven Creek Site (NWP)
TL-1, TL-2, TL-EDB	- Transmission line from NPP to East Dry Basin (AQ + Ex)
TL-WDB	- Transmission line branch to West Dry Basin (Ex)
TL-BM	- Transmission line branch to Big Mesa (Ex)
TL-SL	- Transmission line branch to sulfur loadout (AQ + Ex)
TL-N-CC	- Transmission line from NPP to Craven Creek Site (NWP)
SG-EDB-Q	- Sour gas trunkline to East Dry Basin (AQ)

SG-EDB-W	-	Sour gas trunkline to East Dry Basin (W)
SG-WDB	-	Sour gas trunkline to West Dry Basin (Ex) - within well field
SG-BM	-	Sour gas trunkline to Big Mesa (Ex)
SG-CC	-	Sour gas trunkline to Craven Creek (NWP)
S-CC	-	Sales gas pipeline from Craven Creek site (NWP)
CS-EDB,CS-1, CS-2, CS-3	-	Combined CO ₂ and sales gas corridor from East Dry Basin (AQ) to Trailblazer
CS-WDB	-	CO ₂ and sales gas branch from West Dry Basin (Ex)
CS-BM	-	CO ₂ and sales gas branch from Big Mesa (Ex)
C-CC	-	CO ₂ pipeline from Craven Creek Site to MAPCO (NWP)
SP-1, SP-WDB	-	Sulfur pipeline from West Dry Basin to loadout (Ex)
SP-EDB-WDB	-	Sulfur pipeline from East Dry Basin to West Dry Basin (AQ)
SP-BM	-	Sulfur pipeline branch to Big Mesa (Ex)
W-CC	-	Water pipeline from Green River to Craven Creek (NWP)
A-CC	-	Access road to Craven Creek (NWP)
A-BM	-	Access road to Big Mesa (Ex)

Component Options

RR-WDB	-	Railroad from West Dry Basin to Stauffer Chemical spur (Ex)
	-	Construction camp sites
C-WDB		West Dry Basin (Ex)
C-EDB		East Dry Basin (AQ)
C-BM		Big Mesa (Ex)

BUCKHORN ALTERNATIVE

Non-Linear Facilities

BH	Buckhorn (AQ)
WDB	West Dry Basin (Ex)
EDB-Ex	East Dry Basin (Ex)
CC	Craven Creek (NWP)
SL	Sulfur Loadout

Linear Facilities

RR-CC	-	Railroad spur to Craven Creek Site (NWP)
TL-1, TL-BH	-	Transmission line from NPP to Buckhorn (AQ + Ex)
TL-2, TL-WDB	-	Transmission line branch to West Dry Basin (Ex)
TL-EDB	-	Transmission line branch to East Dry Basin (Ex)
TL-SL	-	Transmission line branch to sulfur loadout (AQ + Ex)
TL-N-CC	-	Transmission line from NPP to Craven Creek Site (NWP)
SG-BH-Q	-	Sour gas trunkline to Buckhorn (AQ)
SG-BH-W	-	Sour gas trunkline to Buckhorn (W)
SG-WDB	-	Sour gas trunkline to West Dry Basin (Ex) - within well field
SG-EDB-E	-	Sour gas trunkline to East Dry Basin (Ex)
SG-CC	-	Sour gas trunkline to Craven Creek (NWP)
S-CC	-	Sales gas pipeline from Craven Creek site (NWP)
CS-WDB, CS-1, CS-2, CS-3	-	Combined CO ₂ and sales gas corridor from West Dry Basin (Ex) to Trailblazer
CS-BH	-	CO ₂ and sales gas branch from Buckhorn (AQ)
CS-EDB	-	CO ₂ and sales gas branch from East Dry Basin (Ex)
C-CC	-	CO ₂ pipeline from Craven Creek Site to MAPCO (NWP)
SP-1, SP-2 SP-EDB	-	Sulfur pipeline from East Dry Basin (Ex) to loadout
SP-EDB-WDB	-	Sulfur pipeline from East Dry Basin (Ex) to WDB (Ex)
SP-BH	-	Sulfur pipeline from Buckhorn (AQ)
W-CC	-	Water pipeline from Green River to Craven Creek (NWP)
A-CC	-	Access road to Craven Creek (NWP)
A-BH	-	Access road to Buckhorn (AQ)

Component Options

	-	Construction camp sites
C-WDB		West Dry Basin (Ex)
C-BH		Buckhorn (AQ)

SHUTE CREEK ALTERNATIVE

Non-Linear Facilities

BH	Buckhorn (AQ)
CC	Craven Creek (NWP)
SC	Shute Creek (Ex)
SL	Sulfur Loadout Facility

Linear Facilities

RR-CC	-	Railroad spur to Craven Creek Site (NWP)
TL-1, TL-BH	-	Transmission line from NPP to Buckhorn (AQ + Ex)
TL-SC	-	Transmission line branch to Shute Creek (Ex)
TL-SL	-	Transmission line branch to sulfur loadout (AQ + Ex)
TL-N-CC	-	Transmission line from NPP to Craven Creek (NWP)
SG-BH	-	Sour gas trunkline to Buckhorn (AQ)
SG-BHW	-	Sour gas trunkline to Buckhorn (W)
SG-SC	-	Sour gas trunkline to Shute Creek (Ex)
SG-CC	-	Sour gas trunkline to Craven Creek (NWP)
S-CC	-	Sales gas pipeline from Craven Creek site (NWP)
CS-BH, CS-2, CS-3	-	Combined CO ₂ and sales gas corridor from Buckhorn (AQ) to Trailblazer
CS-SC	-	CO ₂ and sales gas branch from Shute Creek (Ex)
C-CC	-	CO ₂ pipeline from Craven Creek Site to MAPCO (NWP)
SP-1, SP-2, SP-BH	-	Sulfur pipeline from Buckhorn to loadout (AQ)
SP-SC	-	Sulfur pipeline branch to Shute Creek (Ex)
W-CC	-	Water pipeline from Green River to Craven Creek (NWP)
A-CC	-	Access road to Craven Creek (NWP)
	-	Access roads (3) to Shute Creek (Ex)
A-SC-W		
A-SC-S		
A-SC-N		
A-BH	-	Access road to Buckhorn (AQ)

Component options

RR-SC	-	Railroad spur from Craven Creek to Shute Creek (Ex)
	-	Construction camp sites
C-BH		Buckhorn (AQ)
C-SC		Shute Creek (Ex)

NORTHERN ALTERNATIVE

Non-Linear Facilities

- WDB - West Dry Basin (Ex)
- BH - Buckhorn (AQ)
- BM - Big Mesa (Ex)
- EDB-N - East Dry Basin (NWP)
- SL - Sulfur Loadout

Linear Facility

- TL-1, TL-2, TL-WDB - Transmission line from NPP to West Dry Basin (Ex)
- TL-BH - Transmission line branch to Buckhorn (AQ)
- TL-BM - Transmission line branch to Big Mesa (Ex)
- TL-EDB - Transmission line branch to East Dry Basin (NWP)
- TL-SL - Transmission line branch to sulfur loadout (AQ, Ex, NWP)
- SG-WDB - Sour gas trunkline to West Dry Basin (Ex)
- SG-BH-Q - Sour gas trunkline to Buckhorn (AQ)
- SG-BH-W - Sour gas trunkline to Buckhorn (W)
- SG-BM - Sour gas trunkline to Big Mesa (Ex)
- SG-EDB-N - Sour gas trunkline to East Dry Basin (NWP)
- CS-WDB, CS-1, CS-2, CS-3 - Sales gas and CO₂ pipeline from West Dry Basin to Trailblazer (Ex + AQ)
- CS-BH - Sales gas and CO₂ pipeline branch from Buckhorn (AQ)
- CS-BM - Sales gas and CO₂ pipeline branch from Big Mesa (Ex)
- CS-EDB - CO₂ (only) branch from East Dry Basin (NWP)
- S-EDB - Sales gas pipeline from East Dry Basin (NWP)
- SP-1, SP-WDB - Sulfur pipeline from West Dry Basin to loadout (Ex + AQ)
- SP-BH - Sulfur pipeline branch from Buckhorn (AQ)
- SP-BM - Sulfur pipeline branch from Big Mesa (Ex)
- SP-EDB-WDB - Sulfur pipeline branch from East Dry Basin (NWP) to West Dry Basin (EX)
- SP-EDB - Sulfur pipeline branch from SP-BH to East Dry Basin (NWP)
- A-BH - Access road to Buckhorn (AQ)
- A-BM - Access road to Big Mesa (Ex)

Component options

- Construction camp sites
- C-BM Big Mesa (Ex)
- C-WDB West Dry Basin (Ex)
- C-BH Buckhorn (AQ)

FISHERIES TECHNICAL REPORT
FOR THE RILEY RIDGE
ENVIRONMENTAL IMPACT STATEMENT

April 1983

Principal Preparers:

Dan Keefe
Bob Martinson
Ron Sutton
Environmental Research & Technology, Inc.

For Further Information Contact:

Bureau of Land Management
Division of Environmental Impact Statement
Services
555 Zang Street, First Floor East
Denver, Colorado 80228

This technical report was reviewed by agency specialists included in the List of Preparers in the Riley Ridge Draft Environmental Impact Statement.

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INTRODUCTION

This technical report describes existing baseline conditions and potential project impacts from the Riley Ridge Project Proposed Action and Alternatives. This chapter includes two sections: 1) a regional overview discussion of the Upper Green River system and 2) a site-specific discussion of resources affected by project components. Baseline studies conducted for the EIS focused on habitat description [stream flow, habitat quality index (HQI), food base] rather than estimation of fish populations. Habitat parameters can provide an index to a stream's general health and fisheries potential, and can also be used to monitor changes over time. Fluctuations in trout populations, however, are often related to highly variable year-to-year stream flow fluctuations that occur in the well field area (Dunning 1982, personal communication).

REGIONAL OVERVIEW

The aquatic habitats in and around the project area (Sublette, Lincoln, and Sweetwater Counties) are very diverse and include large rivers, very small headwater streams, high mountain lakes, reservoirs, and wetlands. No commercial fishing has been documented in the Green River drainage; however, recreational fishing is very popular. The region's aquatic resources provide some of the nation's best trout fishing. The more important recreational species include rainbow, brown, brook, and cutthroat trout and mountain whitefish. Table 1-1 contains a list of fish species in the upper Green River drainage in Wyoming.

Numerous streams containing brown, rainbow, brook, and the rare Colorado River cutthroat trout drain the proposed well field. Well field streams that contain Colorado River cutthroat trout comprise part of the Westside Tributaries to the Green River and are considered one of three remaining enclaves of the Colorado River cutthroat (Binns 1977). The Colorado River cutthroat trout has declined in numbers in recent years and is considered a rare species by the Wyoming Game and Fish Department (WGF), and a sensitive species by the Bureau of Land Management (BLM) and the Forest Service (FS) (Binns 1977).

The Green River in the vicinity of the well field, and including Fontenelle Reservoir and downstream, contains a quality (Class II) cold water game fishery. Regional streams are depicted on Wildlife Map 1-5 in the Map Pocket of this report. Fish present include cutthroat trout, rainbow trout, brown trout, and mountain whitefish. Fontenelle Reservoir contains brown, rainbow, and cutthroat trout as well as lake trout and Kokanee salmon.

Fontenelle Creek and LaBarge Creek are important tributaries to the Green River and would be crossed by project-related pipelines and transmission lines. Both streams are Class II cold water streams. Fontenelle Creek in

TABLE 1-1

FISH SPECIES IN THE UPPER GREEN RIVER DRAINAGE IN WYOMING¹

Family ² Species ²	Common Name ²	Relative Abundance ^{1,3}	Threatened or Endangered ⁴		Recreationally Important ²
			Federal	State	
Salmonidae					
<u>Prosopium williamsoni</u>	Mountain whitefish	A			X
<u>Oncorhynchus nerka</u>	Sockeye salmon (Kokanee)	U			X
<u>Salmo clarki bouvieri</u>	Yellowstone cutthroat	U			X
<u>S.C. subsp.</u>	Snake River cutthroat	C			X
<u>S.C. pleuriticus</u>	Colorado River cutthroat ⁵	U		X	X
<u>S. gairdneri</u>	Rainbow trout	A			X
<u>S. aquabonita</u>	Golden trout	C			X
<u>S. trutta</u>	Brown trout	A			X
<u>Salvelinus namaycush</u>	Lake trout	C			X
<u>S. fontinalis</u>	Brook trout	A			X
<u>Thymallus arcticus</u>	Arctic grayling	C			X
Cyprinidae					
<u>Cyprinus carpio</u>	Common carp	C			X
<u>Semotilus atromaculatus</u>	Creek chub	U			
<u>Corresus pulumbens</u>	Lake chub	C			
<u>Gila atraria</u>	Utah chub	C			
<u>G. robusta</u>	Roundtail chub	C			
<u>G. elegans</u>	Bonytail chub ⁶	R	X	X	
<u>Richardsonius balteatus</u>	Redside shiner	A			
<u>Rhinichthys osculus</u>	Speckled dace	C			

TABLE 1-1 (CONTINUED)

Family ² Species ²	Common Name ²	Relative Abundance ^{1,3}	Threatened or Endangered ⁴ Federal State	Recreationally Important ²
Cyprinidae (Continued)				
<u>R. cataractae</u>	Longnose dace	U		
<u>Pimephales promelas</u>	Fathead minnow	C		
Catostomidae				
<u>Catostomus commersoni</u>	White sucker	U		
<u>C. catostomus</u>	Longnose sucker	U		
<u>C. latipinnis</u>	Flannelmouth sucker	C		
<u>C. platyrhynchus</u>	Mountain sucker	A		
<u>C. discobolus</u>	Bluehead sucker	C		
Centrarchidae				
<u>Micropterus dolomieu</u>	Smallmouth bass	U		X
<u>M. salmoides</u>	Largemouth bass	U		X
Cottidae				
<u>Cottus bairdi</u>	Mottled sculpin	A		

¹Source: Baxter and Simon (1970), Miller (1978), Remmick (1981). Verified by Remmick (1982).

²In accordance with American Fisheries Society (1980).

³A = abundant, C = Common, U = uncommon, R = rare.

⁴In accordance with species listings presented in Federal Register (1980) and Wyoming Game and Fish Department (1977).

⁵Sensitive species according to WFG, BLM, and USFS (Binns 1977).

⁶Bonytail chub has not been verified in Wyoming for many years.

its lower reach contains rainbow, brown, brook, cutthroat trout, and mountain whitefish. Populations are generally low, with rainbow the dominant trout. This creek is used by rainbow trout from Fontenelle Reservoir for spawning. LaBarge Creek game fish include rainbow, brown, brook, cutthroat trout, and mountain whitefish. Populations are low to moderate (Remmick 1981).

According to the BLM's East Front Aquatic Management Plan (EFAMP), many streams important to Colorado River cutthroat trout survival exist within the North Piney/Middle Piney, South Piney, and Dry Piney Management Areas, which lie within the well field boundaries. These areas have been further subdivided into Management Areas A and B. Management Area A, which is primarily on public national resource lands (NRL), lies east of the Range 113-114 Township line and is a cold desert plain and foothills region. Management Area B lies between the National Forest Boundary and the Range 113-114 Township line and encompasses the entire known range of Colorado River cutthroat trout within the eastern front of the Wyoming Range on the Pinedale Resource Area. This area contains North Fork Beaver Creek, which is one of only three streams (Rock Creek, Nylander Creek, and North Beaver Creek) in the Westside Tributaries Enclave that contains pure Colorado River cutthroat trout. The BLM management plans call for granting this stream highest management priority in order to protect this sensitive population (BLM 1978).

Streams in the BLM management areas drain highly erodible sedimentary soils that are susceptible to erosion. Historical and existing multiple-use practices that have resulted in erosion problems include timber development, livestock use, minerals (including oil and gas) development, and recreational use. A recent BLM stream inventory (1975 to 1977) indicated that the streams within the EFAMP area have an apparent 75 percent declining and 25 percent stable habitat trend.

The objectives of the BLM's EFAMP may be summarized as follows:

- Ensure the long-term survival of the pure Colorado River cutthroat trout in North Beaver Creek and Rock Creek; and
- Improve habitat in streams currently supporting or potentially capable of supporting Colorado River cutthroat trout by:
 - a) Improving channel stability,
 - b) Increasing spawning and resident fish (e.g., beaver ponds) habitat,
 - c) Reversing declining habitat trend,
 - d) Improving riparian habitat,
 - e) Establishing stream and riparian exclosures,
 - f) Annually improving 1 mile of stream habitat,
 - g) Continuing to conduct habitat inventories, especially in Area A,
 - h) Developing adequate recreation and road maintenance programs along South Piney Creek and LaBarge Creek,

- i) Attaining grazing management systems (allowing for two years minimum rest between treatments),
- j) Acquiring key land parcels to consolidate public land status, and
- k) Attaining maximum protection or mitigation from oil and gas activities (BLM 1978).

Meeting these objectives will require interagency cooperation and restrictions on some uses in order to protect aquatic habitat.

SITE SPECIFIC

WELL FIELD

General Habitat Description

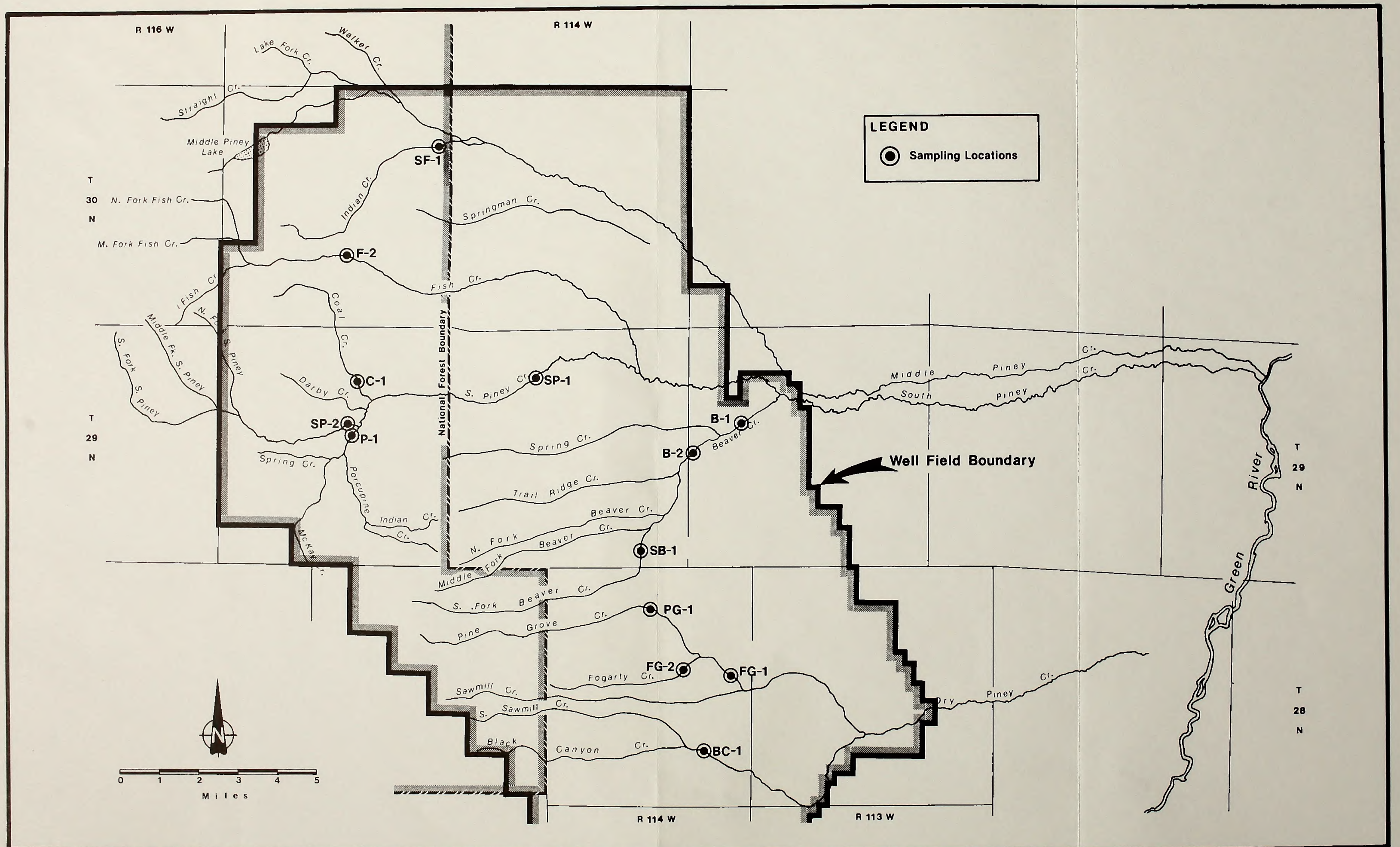
The major streams draining the well field are South Piney Creek and Middle Piney Creek. Map 1-1 shows the streams that flow through the well field and aquatic sampling locations. Table 1-2 provides legal descriptions of the sampling locations. The streams in the well field occur at elevations between 7,000 and 10,000 feet and have low to moderate gradients, beaver ponds, and meanders in the middle and lower elevations. The numerous beaver ponds create habitat critical to fish during drought periods and help regulate the deposition of sediment in the streams. They also increase the area of suitable habitat available to riparian vegetation which provides stream bank cover. Riparian vegetation generally consists of low-growing willows and/or grasses. In some areas, livestock have disrupted the riparian vegetation. In addition, irrigation diversions occur on the lower portions of Middle and South Piney Creeks, altering natural channels, stream flows and the occurrence of riparian vegetation.

Water quality of the well field area streams is generally favorable for fish production. However, irrigation, timber cutting, mining, mineral exploration, and livestock grazing have increased water temperatures and siltation (Remmick 1981). Low flows from irrigation and droughts limit fish production. Therefore, beaver ponds are very important as holding areas for fish populations during low flow periods (Remmick 1981).

Streams toward the southern end of the well field area (Dry Piney Creek drainage) are generally small (less than 4 feet wide) and can be rather turbid during heavy runoff. Grazing occurs along most of their lengths, and flows often cease during dry years.

Streams in the Beaver Creek drainage in the middle of the well field range from 3 to 10 feet in width and can be turbid in the lower reaches. Grazing also occurs along their middle and lower reaches, and they may cease flowing during arid years.

The streams at the northern end of the well field area (north of the Beaver Creek drainage) in the South Piney and Middle Piney drainages are very diverse, ranging from small headwater rivulets less than 1 foot wide to



MAP 1-1 STREAM FLOW AND WATER QUALITY SAMPLING LOCATIONS

TABLE 1-2
LOCATIONS OF THE AQUATIC SAMPLING STATIONS

Sampling Station Name	Stream	Range	Township	Section
SF-1	South Fork Middle Piney Creek (Indian Creek)	115W	30N	12
F-2	Fish Creek	115W	30N	28
C-1	Coal Creek	115W	29N	10
P-1	Porcupine Creek	115W	29N	12
SP-2	Upper South Piney Creek	115W	29N	12
SP-1	Lower South Piney Creek	114W	29N	7
B-1	Beaver Creek	113W	29N	18
SB-1	South Beaver Creek	114W	28N	3
PG-1	Pine Grove Creek	114W	28N	10
FG-2	Fogarty Creek	114W	28N	14
FG-1	Fogarty Creek	114W	28N	13
BC-1	Black Canyon Creek	114W	28N	26

fairly large creeks 10 to 20 feet wide. The northern streams are generally clear and unaffected by ranching except in the lower reaches; they apparently do not go dry above irrigation withdrawals.

Benthic Macroinvertebrates

Data from August 1982 collections show that the study area streams generally support abundant and diverse macroinvertebrate communities (Tables 1-3 and 1-4). The total number of taxa ranged from 19 at Station FG-1 to 39 at Station SP-1. At no station was the community composition indicative of severe stress. For example, major aquatic insect groups, such as Ephemeroptera, Plecoptera (a sensitive group), Trichoptera, Coleoptera, and Diptera, were present at each station. The low total mean densities at Stations C-1 and FG-1 were probably due to a high stream gradient at Station C-1 and silted-in substrates at Station FG-1.

The baetid mayfly (Baetis tricaudatus) was the most abundant taxon at all but three of the sampling stations (F-2, SP-2, and BC-1). This species occupies a variety of habitats in North American streams, and members of the genus Baetis inhabit almost any clean Rocky Mountain stream. The trichopteran Glossosoma was the most abundant taxon at Station F-2. Members of this genus inhabit cold, rapid streams. The chironomid Eukiefferiella was the most abundant taxon at Stations SP-2 and BC-1. Members of this genus prefer cool, clear streams.

Diversity values ($\bar{d}$, Shannon-Weaver) were generally high (2.5 to 3.6) at all stations (Tables 1-3 and 1-4). Wilhm (1970) found that $\bar{d}$ generally ranged between 3.0 and 4.0 in unpolluted waters and dropped below 1.0 in polluted waters. Equitability values ranged from 0.27 to 0.64. Values for equitability can range between 0.0 and 1.0, with values lower than 0.5 indicating stream degradation (Weber 1973). Most stations had rather low equitability values during August, suggesting slight levels of stress; however, low values may also reflect the limited sampling.

None of the collected benthic data involved the dimension of time (seasonal/monthly collections were not part of this study). Over seasons or years, population sizes change; some species emerge as others hatch, and dynamic physical, chemical, and biological processes occur within the streams. Therefore, future comparisons should only be made with data gathered during the calendar time that the present data were collected (mid-August).

Fish

Twenty-nine fish species, half of which are recreationally important, have ranges within areas that could be affected by well field, corridor, and facilities development pertaining to the Riley Ridge Project (Table 1-1). Of the game fish species, rainbow trout (Salmo gairdneri), brown trout (Salmo trutta), brook trout (Salvelinus fontinalis), and mountain whitefish (Prosopium williamsoni) are most numerous. The most important forage species are the redbside shiner (Richardsonius balteatus), the mountain sucker (Catostomus platyrhynchus), and the mottled sculpin (Cottus bairdi).

TABLE 1-3
MEAN MACROINVERTEBRATE DENSITIES IN NUMBERS/m² AND PERCENT RELATIVE ABUNDANCES
AT SIX OF ELEVEN STREAM SAMPLING STATIONS

Taxon	Sampling Stations				
	SF-1	F-2	C-1	P-1	SP-1
Tricladida					
Planariidae					
<u>Polycelis coronata</u>		297.8 (9.8)	3.6 (0.5)		21.5 (0.3)
Oligochaeta					
Haplotaxidae					
<u>Haplotaxis gordioides</u>					3.6 (0.1)
Lumbricidae					
<u>Eiseniella tetraedra</u>	3.6 (0.1)				
Tubificidae					
<u>Limnodrilus</u>		229.6 (7.6)	14.4 (1.9)	3.6 (0.1) 10.8 (0.3)	35.9 (0.5) 3.6 (0.1)
<u>Tubifex</u>	17.9 (0.4)				
Gastropoda					
Lymnaeidae					
<u>Lymnaea</u>					3.6 (0.1)
Planorbidae					
<u>Gyraulus</u>	7.2 (0.1)				
Pelecypoda					
Sphaeriidae					
<u>Pisidium</u>					21.5 (0.4) 43.0 (0.6)
Ephemeroptera					
Baetidae					
<u>Baetis bicaudatus</u>		143.5 (4.7)			1926.7 (28.4)
<u>Baetis tricaudatus</u>		3.6 (0.1)	383.9 (49.5) 3.6 (0.5)	911.3 (17.3) 46.6 (0.9)	7.2 (0.1)
<u>Pseudocloeon</u>					
EphemereUidae					
<u>Drunella coloradensis</u>		46.6 (1.5)		21.5 (0.6)	53.8 (0.8)
<u>Drunella doddsi</u>				68.2 (1.3)	21.5 (0.3)
<u>Drunella grandis</u>		21.6 (0.7)		78.9 (1.5)	254.7 (3.8)
<u>Serratella tibialis</u>	125.6 (2.5)			7.2 (0.2)	

TABLE 1-3 (CONTINUED)

Taxon	Sampling Stations				
	SF-1	F-2	C-1	P-1	SP-1
Ephemeroptera (Continued)					
Heptageniidae					
<u>Cinygmula</u>					
<u>Epeorus albertae</u>	21.6 (0.4)	147.1 (4.8)	10.8 (1.4)	17.9 (0.5)	57.4 (1.1)
<u>Rhithrogena</u>	35.9 (0.7)	244.0 (8.0)	3.6 (0.5)		35.9 (0.7)
		10.8 (0.4)	3.6 (0.5)	17.9 (0.5)	1083.6 (20.6)
Leptophlebiidae					
<u>Paraleptophlebia</u>	17.9 (0.4)			7.2 (0.2)	3.6 (0.1)
Plecoptera					
Capniidae (immature)					
	175.8 (3.4)	10.8 (0.4)		3.6 (0.1)	
Chloroperlidae					
<u>Alloperla</u>	18.0 (0.4)	43.0 (1.4)	21.6 (2.8)	35.9 (0.9)	294.2 (5.6)
Nemouridae					
<u>Amphinemura banksi</u>	21.5 (0.4)				
<u>Zapada</u>	7.2 (0.1)	322.9 (10.6)			3.6 (0.1)
Perlidae					
<u>Hesperaperla pacifica</u>	14.4 (0.3)		14.4 (1.9)	14.4 (0.4)	10.8 (0.2)
Perlodidae					
<u>Isoperla</u> sp.			3.6 (0.5)	43.0 (1.1)	32.3 (0.6)
<u>Skwala parallela</u>	46.6 (0.9)	7.2 (0.2)			53.8 (0.8)
Pteronarcidae					
<u>Pteronarcella badia</u>					10.8 (0.2)
Megaloptera					
Sialidae					
<u>Sialis</u>				10.8 (0.3)	
Trichoptera					
Brachycentridae					
<u>Brachycentrus</u>	14.4 (0.3)	7.2 (0.2)	10.8 (1.4)	46.6 (1.2)	28.7 (0.5)
Glossosomatidae					
<u>Glossosoma</u>		1065.6 (35.0)		3.6 (0.1)	7.2 (0.1)
Hydropsychidae					
<u>Arctopsyche grandis</u>	10.8 (0.2)	28.7 (0.9)		35.9 (0.9)	75.3 (1.1)
Hydroptilidae					
<u>Ochrotrichia</u>	132.7 (2.6)				10.8 (0.2)
Limnephilidae					
<u>Dicosmoecus</u>			32.3 (4.2)		50.2 (0.7)

TABLE 1-3 (CONTINUED)

Taxon	Sampling Stations				
	SF-1	F-2	C-1	P-1	SP-1
Trichoptera (Continued)					
Rhyacophilidae					
Rhyacophila acropedes		18.0 (0.6)	21.5 (2.8)	28.7 (0.7)	10.8 (0.2)
Rhyacophila angelita		28.7 (0.9)			50.2 (0.7)
Coleoptera					
Dytiscidae					
Liodessus					3.6 (0.1)
Elmidae					
Heterolimnius corpulentus		10.8 (0.4)			
Optioservus quadramaculatus-					
seriatus	853.9 (16.7)	3.6 (0.1)	14.4 (1.9)	78.9 (2.1)	57.4 (1.1)
Zaitzevia parvula	140.1 (2.7)		18.0 (2.3)	46.7 (1.2)	7.2 (0.1)
					1374.2 (20.2)
					28.8 (0.4)
Diptera					
Ceratopogonidae					
Palpomyia		10.8 (0.4)			3.6 (0.1)
Chironomidae					
Chironominae					
Paracladopelma				3.6 (0.1)	
Polypedilum					14.4 (0.2)
Rheotanytarsus		3.6 (0.1)			
Tanytarsus	179.4 (3.5)		3.6 (0.5)	53.8 (1.4)	35.9 (0.7)
					326.6 (4.8)
Diamesinae					
Pothastia		46.7 (1.5)	3.6 (0.5)		
Pseudodiamesa			21.5 (2.8)		18.0 (0.3)
Orthocladinae					
Brillia		3.6 (0.1)			
Cardiocladius	10.8 (0.2)	21.6 (0.7)		39.6 (1.0)	3.6 (0.1)
Corynoneura	3.6 (0.1)			7.2 (0.2)	3.6 (0.1)
Cricotopus	78.9 (1.5)	7.2 (0.2)		157.9 (4.1)	125.6 (2.4)
Eukiefferiella A	678.2 (13.3)	100.5 (3.3)	50.2 (6.5)	522.6 (13.7)	545.1 (8.0)
Eukiefferiella B	100.5 (2.0)	18.0 (0.6)	18.0 (2.3)		523.8 (7.7)
Eukiefferiella C	157.9 (3.1)	68.2 (2.2)	21.5 (2.8)	58.3 (1.1)	3.6 (0.1)
Heterotrissocladius	28.7 (0.6)		3.6 (0.5)	14.4 (0.4)	82.5 (1.2)
Orthocladus				7.2 (0.2)	32.3 (0.5)
Psectrocladius					143.5 (2.7)
Thienemannella	35.9 (0.7)				3.6 (0.1)
Tanypodinae					
Conchapelopia	39.5 (0.8)		3.6 (0.5)		
pupae	98.9 (1.9)	18.0 (0.6)	14.4 (1.9)	75.3 (2.0)	61.0 (1.2)
					61.0 (0.9)

TABLE 1-3 (CONTINUED)

Taxon	Sampling Stations				
	SF-1	F-2	C-1	P-1	SP-1
Diptera (Continued)					
Empididae					
Chelifera	18.0 (0.4)	28.7 (0.9)	32.3 (4.2)	7.2 (0.2)	190.2 (2.8)
Wiedemannia	3.6 (0.1)				
Simuliidae					
<u>Simulium argus-pugetense-</u> <u>venustum-vittatum</u>	258.3 (5.1)	3.6 (0.1)	7.2 (0.9)	541.8 (14.2)	387.5 (7.4)
Statiomyidae					
Nemotelus		3.6 (0.1)		3.6 (0.1)	
Tipulidae					
Antocha		7.2 (0.2)			3.6 (0.1)
Dicranota	25.1 (0.5)				
Hexatoma	43.1 (0.8)	10.8 (0.4)	35.9 (4.6)	53.8 (1.4)	68.2 (1.0)
Ormosia	3.6 (0.1)				
Total Mean Numbers/m ²	5108.3	3043.2	775.5	3827.3	6789.3
Total Number of Taxa	36	34	26	31	39
Diversity (d)	3.4	3.4	3.1	2.6	3.5
Equitability (e)	0.42	0.44	0.47	0.27	0.42

TABLE 1-4
MEAN MACROINVERTEBRATE DENSITIES IN NUMBERS/m² AND PERCENT RELATIVE ABUNDANCES
AT FIVE OF ELEVEN STREAM SAMPLING STATIONS

Taxon	Sampling Stations				
	B-1	SB-1	PG-1	FG-1	BC-1
Oligochaeta					
Lumbricidae					
<u>Eiseniella tetraedra</u>		21.6 (1.1)	82.5 (2.7)	10.8 (1.0)	
Naididae					
<u>Nais communis</u>	7.2 (0.3)				21.5 (0.4)
Tubificidae					
<u>Limnodrilus</u>	10.8 (0.4)				
Pelecypoda					
Sphaeriidae					
<u>Pisidium</u>	3.6 (0.1)	21.6 (1.1)			21.5 (0.4)
Amphipoda					
Gammaridae					
<u>Gammarus lacustris</u>					43.1 (0.8)
Ephemeroptera					
Baetidae					
<u>Baetis tricaudatus</u>		803.7 (42.7)	1051.2 (34.3)	452.1 (41.9)	93.3 (1.8)
<u>Baetis insignificans</u>	1309.6 (51.1)			7.2 (0.7)	25.1 (0.5)
Ephemerellidae					
<u>Ephemerella infrequens</u>			3.6 (0.1)		7.2 (0.1)
Heptageniidae					
<u>Cinygmula</u>		39.5 (2.1)			
<u>Heptagenia</u>	3.6 (0.1)	7.2 (0.4)	538.2 (17.6)	32.3 (3.0)	
<u>Rhithrogena</u>					
Leptophlebiidae					
<u>Paraleptophlebia</u>	10.8 (0.4)	7.2 (0.4)	25.1 (0.8)	14.3 (1.3)	28.7 (0.5)
Plecoptera					
Capniidae (immature)	7.2 (0.3)	14.3 (0.8)			14.4 (0.3)
Chloroperlidae					
<u>Alloperla</u>		46.6 (2.5)			

TABLE 1-4 (CONTINUED)

Taxon	Sampling Stations			
	B-1	SB-1	PG-1	FG-1
Plecoptera (Continued)				
Nemouridae				
Zapada		3.6 (0.2)		
Perlidae			21.5 (0.7)	
<u>Hesperoperla pacifica</u>				
Perlodidae			61.0 (2.0)	157.9 (14.6)
<u>Isoperla pinta</u>				
<u>Isoperla</u> sp.	32.3 (1.3)	21.5 (1.1)		32.3 (0.6)
<u>Skwala parallela</u>				
Pteronarcidae				
<u>Pteronarcella badia</u>				18.0 (1.7)
Hemiptera				
Corixidae				7.2 (0.1)
<u>Trichocorixa</u>				
Notonectidae				
<u>Buenoa</u>				3.6 (0.3)
Trichoptera				
Brachycentridae				
<u>Brachycentrus</u>	7.2 (0.3)			
Hydropsychidae				
<u>Hydropsyche</u>	35.9 (1.4)			57.4 (1.1)
Hydroptilidae				
<u>Hydroptila</u>				122.0 (2.3)
Limnephilidae				
<u>Dicosmoecus</u>		7.2 (0.4)		
<u>Hesperophylax</u>			18.0 (0.6)	7.2 (0.1)
Rhyacophilidae				
<u>Rhyacophila acropedes</u>		7.2 (0.4)		
Coleoptera				
Dryopidae				
<u>Helichus</u>		3.6 (0.2)		3.6 (0.1)
Dytiscidae				
<u>Agabus</u>			3.6 (0.1)	35.9 (0.7)
<u>Deronectes</u>				

TABLE 1-4 (CONTINUED)

Taxon	Sampling Stations				
	B-1	SB-1	PG-1	FG-1	BC-1
Coleoptera (Continued)					
<u>Liodes</u>	7.2 (0.3)	358.8 (19.1)	638.7 (20.9)	43.0 (4.0)	7.2 (0.1)
<u>Neoclypeodytes</u>		3.6 (0.2)			
Elmidae					
<u>Optioservus quadramaculatus</u> -					
<u>seriatus</u>	71.8 (2.8)	3.6 (0.2)	3.6 (0.1)	18.0 (1.7)	355.2 (6.8)
<u>Zaitzevia parvula</u>	28.7 (1.1)	7.2 (0.4)	3.6 (0.1)		93.3 (1.8)
Diptera					
Anthomyiidae					
<u>Limnophora aquefrons</u>			10.8 (0.4)		7.2 (0.1)
Chironomidae					
Chironominae					
<u>Polypedilum</u>					
<u>Tanytarsus</u>	50.2 (2.0)	14.4 (0.8)	10.8 (0.4)	7.2 (0.7)	25.1 (0.5)
Diamesinae					162.4 (3.1)
<u>Potthastia</u>		7.2 (0.4)			
<u>Pseudodiamesa</u>		3.6 (0.2)			
Orthocladinae					
<u>Cardiocladius</u>	7.2 (0.3)	7.2 (0.4)	10.8 (0.4)	17.9 (1.7)	3.6 (0.1)
<u>Corynoneura</u>		3.6 (0.2)			
<u>Cricotopus</u>	32.3 (1.3)	168.6 (9.0)	10.8 (0.4)	64.6 (6.0)	1463.9 (27.9)
<u>Eukiefferiella A</u>	287.0 (11.2)	211.7 (11.3)	28.7 (0.9)	39.5 (3.7)	764.3 (14.5)
<u>Eukiefferiella B</u>	150.7 (5.9)		28.7 (0.9)	32.3 (3.0)	190.2 (3.6)
<u>Eukiefferiella C</u>		21.5 (1.1)	7.2 (0.2)		
<u>Heterotrissocladius</u>	28.8 (1.1)			10.8 (1.0)	617.1 (11.7)
<u>Orthocladus</u>					86.1 (1.6)
<u>Thienemanniella</u>					269.1 (5.1)
Tanypodinae					
<u>Conchapelopia</u>			21.5 (0.7)	32.3 (3.0)	197.4 (3.8)
pupae	28.7 (1.1)				
<u>Dixidae</u>	14.4 (0.6)	3.6 (0.2)	10.8 (0.4)	17.9 (1.7)	111.2 (2.1)
<u>Dixa</u>					
<u>Empididae</u>		3.6 (0.2)		28.7 (2.7)	10.8 (0.2)
<u>Chelifera</u>					
<u>Hemerodromia</u>		21.5 (1.1)			21.5 (0.4)
<u>Wiedemannia</u>		3.6 (0.2)			

TABLE 1-4 (CONTINUED)

Taxon	Sampling Stations				
	B-1	SB-1	PG-1	FG-1	BC-1
Diptera (Continued)					
Psychodidae					
<u>Pericoma</u>					3.6 (0.1)
Simuliidae					
<u>Simulium argus-pugetense-venustum-vittatum</u>	398.3 (15.5)	28.7 (1.5)	470.0 (15.4)	71.8 (6.6)	315.8 (6.8)
Stationomyidae					
<u>Euparyphus</u>					18.0 (0.3)
Tipulidae					
<u>Dicranota</u>					28.7 (0.5)
<u>Hexatoma</u>	28.7 (1.1)	3.6 (0.2)			21.6 (0.4)
Total Mean Numbers/m ²	2562.2	1880.4	3060.7	1080.2	5293.7
Total Number of Taxa	22	30	21	19	35
Diversity (d)	2.5	2.8	2.6	3.1	3.6
Equitability (e)	0.35	0.32	0.4	0.64	0.49

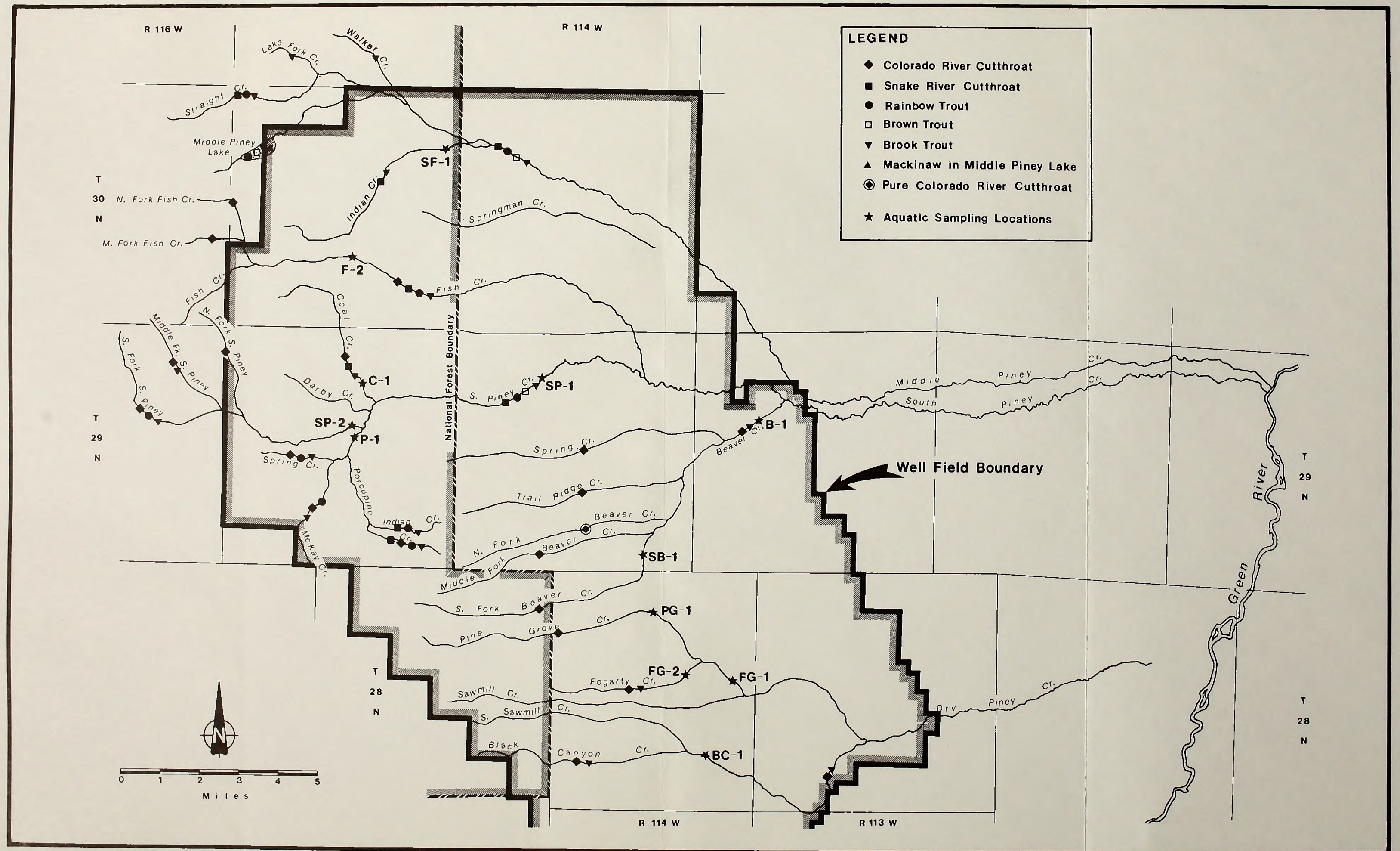
Over the past 18 years WGF has studied fish populations in the Riley Ridge study area (Miller 1978; Remmick 1981). Ten fish species/subspecies have been collected in 30 streams and 1 lake in the well field area (Table 1-5). Five trout species/subspecies inhabit this area and support a recreational fishery (Map 1-2). Brook trout are distributed throughout well field area streams. Historically, brook trout have inhabited Forgarty Creek and Beaver Creek, however, these fish have not been taken in recent WGF surveys (Remmick 1982, personal communication). Species occurrence presented on Map 1-2 is based on published data (Remmick 1981). Colorado River cutthroat trout are in most of the southern and some of the northern streams. In addition to brook trout, most of the northern streams in the well field contain rainbow, brown, and Snake River cutthroat trout (Map 1-2). Reproductive information regarding these species is presented in Table 1-6. Snake River cutthroat trout are no longer stocked in the area, but they may continue to exist in low densities from some limited natural reproduction. Much of South Piney Creek contains self-sustaining populations of rainbow trout.

Fishing pressure is light to moderate, but WGF occasionally stocks the most accessible streams (Middle and South Piney Creeks), mainly with rainbow trout, to supplement natural recruitment (Table 1-7). Fishing pressure in South Piney Creek is currently at a level that may require increased stocking. The game fish populations may be at levels where natural recruitment cannot sustain these wild populations (Remmick 1983, personal communication). Colorado River cutthroat trout are now stocked in place of Snake River cutthroat trout to increase the range of Colorado River cutthroat and to hopefully replace other trout species as the dominant game fish (Remmick 1982, personal communication).

Sensitive Species

The Colorado River cutthroat trout is the only trout species indigenous to the Green River drainage. Hybridization and competition with introduced trout species, as well as man-caused changes in its habitat, have led to its decline. Populations of Colorado River cutthroat trout are usually found in clear, cold (32°F to 68°F) streams above 7,500 feet with gravel-boulder substrates and gradients greater than 4.0 percent. Few other fish species are usually present where cutthroat trout occur. Stream segments with these conditions may be the only areas where Colorado River cutthroat trout can compete with other salmonid species (Sigler and Miller 1963).

Colorado River cutthroat trout are now found in only a few isolated tributaries of the Green, Black's Fork, and Little Snake Rivers in Wyoming (Binns 1977). In the well field area, Black Canyon Creek, Fogarty Creek, Pine Grove Creek, South Fork Beaver Creek, Middle Fork Beaver Creek, North Fork Beaver Creek, Coal Creek, Trail Ridge Creek, South Piney Creek, Fish Creek, Porcupine Creek, and Spring Creek have Colorado River cutthroat trout populations of varying purity (Map 1-2). The population in North Fork Beaver Creek is essentially a pure strain (Binns 1977). Rock Creek and Nylander Creek contain the only other pure populations in the Green River Westside Tributaries Enclave (Binns 1977). These Creeks, however, would not be affected by well field development.



MAP 1-2 AQUATIC SAMPLING LOCATIONS AND DISTRIBUTION OF TROUT SPECIES

TABLE 1-5

DISTRIBUTION OF FISH SPECIES IN STREAMS WITHIN THE RILEY RIDGE WELL FIELD^{1,2,6}

Water Body	Salmo clarki pleuriticus ⁵ Colorado River Cutthroat	Salmo c. bouvieri Snake River Cutthroat	Salmo gairdneri Rainbow Trout	Salmo trutta Brown Trout	Prosopium williamsoni Mountain Whitefish	Salvelinus fontinalis Brook Trout	Cottus bairdi Mottled Sculpin	Rhinichthys cataractae Longnose Dace	Catostomus platyrhynchus Mountain Sucker	Salvelinus namaycush Lake Trout
Dry Piney Creek	X					X	X			
Black Canyon Creek	X					X*	X			
South Sawmill Creek										
Sawmill Creek										
Fogarty Creek	X					X	X			
Pine Grove Creek	X*					X	X			
South Fork Beaver Creek	D					X	X			
Middle Fork Beaver Creek	C*					X	X			
North Fork Beaver Creek	A						X			
Trail Ridge Creek	C*					X	X			
Spring Creek ³	C									
Beaver Creek	X					X	X			
Fish Creek	X	X*				X	X			
South Piney Creek	X	X			X*	X	X	X		
Porcupine Creek	F	X		X		X*	X			
Indian Creek		X		X		X*	X			
McKay Creek	X		X	X		X	X			
Spring Creek ⁴	X		X	X		X	X			
Coal Creek	F	X				X	X			
South Fork South Piney Creek	X		X			X	X			
Middle Fork South Piney Creek	X					X	X			
North Fork South Piney Creek	X					X	X			
Middle Fork Fish Creek	X									
North Fork Fish Creek	X									
Middle Piney Creek		X	X	X		X*	X			
Springman Creek										
Straight Creek		X		X		X	X			
Lake Fork Creek (Sawmill Creek)						X	X			
Bird Creek						X	X			
Middle Piney Lake			X	X						X*

¹Source: Remmick (1981) and Wyoming Game and Fish Commission (1973-1979). Verified by Remmick (1982).²All scientific and common names in accordance with AFS (1980).³Tributary to Beaver Creek.⁴Tributary to South Piney Creek.⁵Rating: A = pure strain to F = poor strain (Binns 1977).⁶Game fish, if known.

*Indicates most abundant.

TABLE 1-6

GENERAL REPRODUCTIVE LIFE HISTORY INFORMATION FOR RECREATIONALLY
IMPORTANT FISH SPECIES IN THE RILEY RIDGE WELL FIELD AREA

Species	Common Name	Spawning Time	Nest	Spawning Areas	Hatching Time	References
<u>Salmo clarki</u>	Cutthroat trout	Spring and early summer after ice breakup (10°C)	Redd	Gravel 0.3-8 cm diameter in riffles	30 days at 10°C	Cope (1957) Duff (1980) Scott and Crossman (1973) Snyder and Tanner (1960)
<u>Salmo gairdneri</u>	Rainbow trout	Spring (10.0°-15.5°C)	Redd	Fine gravel in riffles	44 days at 7.5°C; 29 days at 10.3°C	Embody (1934) Scott and Crossman (1973)
<u>Salmo trutta</u>	Brown trout	Late autumn to early winter (6.7°-8.9°C)	Redd	Shallow, gravelly headwaters	66 days at 7.0°C; 38 days at 10.7°C	Embody (1934) Mansell (1966) Scott and Crossman (1973)
<u>Salvelinus fontinalis</u>	Brook trout	Late summer to autumn	Redd	Shallow, gravelly headwaters	75 days at 6.1°C; 50 days at 10°C	Scott and Crossman (1973)

TABLE 1-7

FISH STOCKING RECORDS FOR STUDY AREA STREAMS 1972-1982

Year	Location	Number	Species of Trout
1972	Coal Creek	2000	Brook
	Fish Creek	2500	Snake River Cutthroat
1973	Fish Creek	1500	Snake River Cutthroat
	South Piney Creek	1000	Rainbow
	Coal Creek	2000	Brook
	Pine Grove Creek	51	Colorado River Cutthroat (Transfer from North Beaver Creek)
1974	Fish Creek	4000	Snake River Cutthroat
	Pine Grove Creek	68	Colorado River Cutthroat (Transfer from North Beaver Creek)
1975	Fish Creek	4000	Snake River Cutthroat
1976	Fish Creek	5000	Snake River Cutthroat
1977	Fish Creek	3500	Snake River Cutthroat
1978	Black Canyon Creek	460	Colorado River Cutthroat
	Fogarty Creek	460	Colorado River Cutthroat
	Pine Grove Creek	1100	Colorado River Cutthroat
	Fish Creek	5100	Snake River Cutthroat
	Cabin Creek	75	Colorado River Cutthroat
1979	North Beaver Creek	450	Colorado River Cutthroat
	Black Canyon Creek	500	Colorado River Cutthroat
	Pine Grove Creek	450	Colorado River Cutthroat
	Fogarty Creek	510	Colorado River Cutthroat
	Middle Piney Creek	1000	Brook (Joe Budd Ranch)
	Middle Piney Creek	3400	Rainbow
	Fish Creek	5000	Snake River Cutthroat
1980	Fish Creek	5000	Snake River Cutthroat
1981	South Piney Creek	9800	Rainbow
	Fish Creek	5000	Snake River Cutthroat
1982	Fish Creek	5000	Colorado River Cutthroat
	Red Castle Creek	480	Colorado River Cutthroat
	Black Canyon Creek	480	Colorado River Cutthroat
	Fogarty Creek	275	Colorado River Cutthroat
	Pine Grove Creek	690	Colorado River Cutthroat
	South Piney Creek	1000	Rainbow

A fish barrier on North Fork Beaver Creek prevents upstream migration of other trout species. The BLM (1977) inventoried the habitat of North Fork Beaver Creek and found good spawning habitat in the upper 3 miles, and 10 beaver ponds were located, none of which were active. The main problem affecting trout habitat cited in this report was sediment from the south-facing slope. This slope is steep, and contains sparse underbrush which does not hold soil very well.

Within the well field streams, Colorado River cutthroat spawning activity tends to occur in the streams' upper reaches. Spawning activities usually occur after peak runoff and until early July; however, spawning is generally associated with a particular water temperature rather than time of year or flow. Hatching of eggs usually occurs during August; fry emerge from the gravel during late August and into September (Quinlan 1980). During the winter, both adults and young of the year rely on stream pools and beaver ponds that are deep enough and have sufficient current and water quality to prevent winter kill (BLM 1980).

Beaver ponds are vital to the continued existence of Colorado River cutthroat trout in the well field streams. Static trout populations are generally associated with declining beaver activity, whereas increasing populations are associated with dynamic beaver activity. A static trout population is one which is dependent upon an upstream increasing population for recruitment. An increasing trout population is one which has active recruitment of its numbers through successful spawning. Transition from increasing to static populations is a function of the cyclical nature of beaver pond ecology, which has been roughly set at 30 years per cycle (BLM 1980). However, in well field streams, beaver ponds appear to cycle every 5 years (Smith 1983, personal communication).

Cutthroat trout are extremely vulnerable to angling pressure. According to McPhee (1966), they are twice as easy to catch as brook trout. Because of their vulnerability, sections of several well field area streams are regulated to prevent anglers from keeping any Colorado River cutthroat trout 10 inches long and under. The purposes of this restriction are to allow cutthroat trout to spawn at least once before being kept by the angler and to increase fisherman harvest of brook trout populations, which have a more liberal creel limit (Remmick 1982, personal communication). The following waters located within the Riley Ridge well field area are included under this special regulation:

- Fish Creek (from Forest boundary, Section 36, R115W, T30N, upstream);
- Beaver Creek drainage (from mouth, Section 9, R113W, T29, upstream); and
- Dry Piney Creek drainage (from mouth; Section 28, R113W, T28N, upstream).

No plans exist to apply this regulation on the South Piney Creek drainage (except Fish Creek) since it supports primarily a rainbow and brook trout

fishery (Remmick 1982, personal communication). If current stocking (see Table 1-7) and regulatory measures are ineffective in preventing further decline, classification of Colorado River cutthroat trout as threatened or endangered in Wyoming may be warranted.

Habitat Quality Index (HQI)

HQI is often used in baseline studies because 1) it eliminates the need for extensive survey work that is often not statistically valid, and 2) it is useful as a monitoring and management tool. Table 1-8 summarizes results of ERT's HQI surveys for selected streams in the Riley Ridge study area, while Appendix A contains calculations for individual streams. In general, larger, faster-flowing streams had higher HQI values than smaller streams. HQIs are used to estimate standing crop of trout using habitat units. A trout habitat unit (HU) is the amount of habitat quality needed to produce an increase in the trout standing crop of 1 pound/acre. Upper South Piney Creek (SP-2) had the highest HQI score (88 pounds of trout/acre or 95 trout HU), and upper Fogarty Creek (FG-2) had the lowest score (12 pounds/ acre or 13 trout HU).

Water flows influence all parameters that determine HQI. Flows were unusually high during 1982 in the Riley Ridge area; therefore, all HQI scores are probably higher than scores for an average water year. For example, the WGF (1980) conducted an HQI survey on Pine Grove Creek September 27, 1980 near the ERT survey location of September 10, 1982. The WGF determined an HQI score of 12.3 pounds/acre compared to ERT's score of 16 pounds/acre (a 23 percent difference).

In summary, the HQI scores showed that the streams with the highest standing crop potential for trout (>30 pounds/acre) were South Piney Creek (SP-1 and SP-2), Fish Creek (F-2), Porcupine Creek (P-1), and Beaver Creek (B-1). The streams with the lower standing crop potentials (<20 pounds/acre) were Fogarty Creek (FG-1 and FG-2), Pine Grove Creek (PG-1), and South Beaver Creek (SB-1).

Instream Flow

The Fish and Wildlife Service (FWS) incremental methodology was used to predict weighted usable areas (WUA) for the different life stages of cutthroat trout at various flows. WUA is defined as the total surface area having a certain combination of hydraulic conditions (depth, velocity, and substrate) multiplied by the composite probability of use by a certain life stage of fish for that combination of conditions (Bovee and Cochnauer 1977). The sensitivity of the simulation model allows for predictions at flows 40 percent less than and 250 percent greater than the measured flow (Trihey and Wegner 1981). Usable habitat cannot be accurately determined for flows outside this range. Instream flow conditions for four life stages of cutthroat trout in streams within the Riley Ridge study area were described in terms of WUA and are expressed as percent of gross surface area in Table 1-9. To determine these optimum flow conditions FWS preference curves for cutthroat trout were used (depth, velocity, and substrate). It is realized that the existing cutthroat curves probably do not accurately reflect specific habitat preference of Colorado River cutthroat since the available area curves are composites from several studies and the habitat

TABLE 1-8
SUMMARY OF HABITAT QUALITY INDEX (HQI) VALUES, BASED UPON DATA
COLLECTED FROM SELECTED STREAMS IN THE RILEY RIDGE
WELL FIELD AREA, SEPTEMBER, 1982

Station		HQI Score lb/acre	Trout Habitat ¹ Units
South Beaver Creek	SB-1	15	16
Beaver Creek	B-1	34	37
Pine Grove Creek	PG-1	16	17
Fogarty Creek	FG-1	19	20
Fogarty Creek	FG-2	12	13
Black Canyon Creek	BC-1	23	25
Indian Creek ²	SF-1	22	24
Fish Creek	F-2	56	60
Coal Creek	C-1	21	23
Porcupine Creek	P-1	39	42
Lower South Piney Creek	SP-1	46	50
Upper South Piney Creek	SP-2	88	95

¹Trout habitat units (HU) = HQI X 1.08; 1.08 is an absolute number which represents the amount that the HQI score changes with a change of one kg/hectare (WGF 1979).

²Formerly South Fork Middle Piney Creek.

TABLE 1-9

AVAILABLE HABITAT AREA AS A PERCENTAGE OF THE GROSS SURFACE AREA IN STREAMS
WITHIN RILEY RIDGE WELL FIELD AREA AT MEASURED FLOW

Stream	Measured Flow (cfs)	Life Stage of Cutthroat Trout (%)			
		Fry	Juvenile	Adults	Spawning
Fish Creek F-2	12	12	16	8	10
Upper South Piney Creek SP-2	22	6	13	20	5
Fogarty Creek FG-1	1	13	6	0	19
Coal Creek C-1	3	10	9	0	29
Lower South Piney Creek SP-1	22	15	27	30	5
Porcupine Creek P-1	3	15	7	3	16
Beaver Creek B-1	6	2	2	0	4
Indian Creek SF-1	2	2	2	0	11
South Beaver Creek SB-1	2	1	0	0	6
Pine Grove Creek PG-1	0.5	2	1	0	4
Fogarty Creek FG-2	0.4	0	0	0	2
Black Canyon Creek BC-1	0.6	0	0	0	1

where Colorado River cutthroat occur is very specialized. However, until data are collected which accurately depict the habitat preferences of Colorado River cutthroat, the FWS curves are assumed to be the best available. Although errors in extrapolation are high at flows less than 10 cubic feet/second, the incremental methodology can be used for streams with flows of 1.0 cubic foot/second or greater (Bovee 1982, personal communication). Most streams in the Riley Ridge area have average annual flows less than 10 cubic feet/second. In fact, only three reaches were surveyed by ERT which had measured flows greater than 10 cubic feet/second (Table 1-9). Any instream flow results in streams with flows less than 10 cubic feet/second are subject to error, especially when the instream flow survey is conducted at one flow (one season). Rounding errors at low flows also add to the simulation error.

At the time of the surveys, cutthroat trout adults, juveniles, and some fry were present in the streams mentioned above. Lower South Piney Creek (SP-1) had the greatest percentage area available for juvenile and adult cutthroat trout (Table 1-9). Lower South Piney Creek (SP-1) and Porcupine Creek (P-1) had the most area available for fry. These streams also had some of the highest HQI scores (Table 1-8).

The figures in Appendix B illustrate the relationship of discharge versus available habitat for cutthroat trout in selected streams in the Riley Ridge study area. Optimal predicted instream flows for a life stage coincide with peaks of the discharge/habitat curves. The peaks represent flow conditions that provide optimal habitat for the life stage under consideration. Curves that do not display obvious peaks suggest a range of flows that would provide optimal habitat conditions. For example, the curve for cutthroat trout fry in South Piney Creek (SP-1) shows that the flow which would provide optimal habitat area is probably between 5 and 10 cubic feet/second (Appendix B, Figure B-9).

Table 1-10 summarizes the flows taken from Appendix B that give optimal cutthroat trout conditions for selected streams in the Riley Ridge study area. These flow data can serve as guidelines for establishing instream flows to provide the best conditions for each life stage of cutthroat trout. To apply these flow guidelines, an understanding of the reproductive timing of cutthroat trout is necessary. Cutthroat trout spawn between April and June. Eggs hatch in about 30 days (Table 1-6); thus, fry are present from June through August. Juvenile (<15 centimeters) cutthroats occur during the fall and winter months (September-March), while adults are present year round. With these time frames, recommended flows can be established to protect each life stage in each stream. Juvenile cutthroat favor more flow than fry or spawning adult life stages. However, stream flows are generally lower in the fall and winter months when juveniles are present than in the spring and summer when eggs and fry are present. Thus, taking water from the streams between April and August would be more desirable than between September and March. Adult cutthroat trout are the least sensitive life stage, and although they require the most flow for optimal conditions, they can survive in lower flows than the other life stages. Also, beaver ponds provide a refuge for adults during low flow periods.

TABLE 1-10

FLOWS PROVIDING OPTIMAL CUTTHROAT HABITAT CONDITIONS
FOR SELECTED STREAMS IN THE RILEY RIDGE
WELL FIELD AREA
(in cubic feet/second)

Stream	Life Stage of Cutthroat Trout			
	Fry	Juvenile	Adult	Spawning
Lower South Piney Creek SP-1	5-10	17	30	5-10
Upper South Piney Creek SP-2	5-10	5-10	13	17
Fish Creek F-2	7	26	29	7
Porcupine Creek P-1	7	8-10	8-10	5
Coal Creek C-1	7-10	7-10	7-10	4
Indian Creek SF-1	6-10	6-10	6-10	2
Beaver Creek B-1	3	15-20	15-20	3
Fogarty Creek FG-1	0-1	3-5	3-5	2
Fogarty Creek FG-2	0-1	2	3-5	0-1
South Beaver Creek SB-1	4	5-10	5-10	4
Pine Grove Creek PG-1	2	3-5	3-5	2
Black Canyon Creek BC-1	0-1	2-5	3-5	0-1

PLANT SITES AND NON-LINEAR FACILITIES

No aquatic habitat occurs on the proposed or alternative plant sites with the exception of Northwest Pipeline's Craven Creek plant site which contains some intermittent tributaries to Craven Creek. Craven Creek's aquatic environment is limited because of intermittent flows, high water temperatures, high alkalinity, and silty sand substrates. This environment does not support a game fishery, and may support only a limited sucker-minnow fishery in its extreme lower reaches.

LINEAR FACILITIES

Table 1-11 provides a summary of the various pipeline crossings for Proposed Action and alternatives. Appendix A in the Wildlife Technical Report references the various codes associated with the corridors for each alternative. Map 1-5 in the map pocket depicts regional streams and linear facility crossings for the Proposed Action and all alternatives. Sales gas and CO₂ pipelines (CS-WDB) associated with the Proposed Action would cross Dry Piney Creek in its lower section, the Green River south of the town of Big Piney, and the Big Sandy River southwest of Farson. A sales gas and CO₂ pipeline (CS-SC) also would cross the Green River in the Seedskaadee Wildlife Refuge. This crossing is associated with the Shute Creek Alternative.

The Green River below Big Piney supports several game and numerous non-game fish species. Game fish include brown and rainbow trout and mountain whitefish. The trout population in the Green River in the Seedskaadee National Wildlife Refuge consists mainly of rainbow and brown trout, with rainbow trout being most abundant. The WGF has recently implemented a habitat improvement plan for the Green River below Fontenelle Dam. The plan will eventually include the Green River to its confluence with the Big Sandy River (Dufek 1982, personal communication). The Big Sandy River below Farson is marginal as a trout fishery. Recent habitat improvement efforts have resulted in providing seasonal habitat for trout which have some recreational value (Smith 1983, personnel communication). A shifting sand bottom limits macroinvertebrate populations, and water temperatures during summer are higher than salmonids usually tolerate (Miller 1978). The Big Sandy River below Farson supports the following non-game fish species: suckers, sculpin, and minnows (Miller 1978). Dry Piney Creek does not support a game fishery in the lower section below Black Canyon Creek (Remmick 1981). A CO₂ pipeline (C-CC) would cross Black's Fork River near Granger, Wyoming. Because of high water temperatures, extreme siltation, and high alkalinity, this reach of Black's Fork River does not support a game fishery, but does support a limited non-game fish community (Remmick 1981).

The sour gas trunk lines would cross the lower reaches of the following streams: South Beaver Creek, Beaver Creek, Fogarty Creek, Dry Piney Creek, Birch Creek, LaBarge Creek, Muddy Creek, Fontenelle Creek, Slate Creek, Sheep Creek, and Jackson Creek. The environments of Fogarty Creek, South Beaver Creek, and Beaver Creek have been discussed in the well field section. The description of the fisheries in the remaining streams relies on data from Remmick (1981). Birch, Muddy, Sheep, and Jackson Creeks are intermittent and do not support fisheries. Lower Slate Creek has a resident non-game fish community of suckers and minnows and a migratory brown trout

TABLE 1-11

SUMMARY OF CORRIDOR PIPELINE STREAM CROSSINGS AND
ASSOCIATED FISHERIES RESOURCES¹

Linear Facility ²	Permanent Stream Crossed (Associated Fish ³)
<u>Proposed Action</u>	
RR-WDB (Component Alternative)	S. Piney Creek (cc, rb, bk, bn, wf, ng), Middle Piney Creek (cc, rb, bk, bn, wf, ng) North Piney Creek (cc, rb, bk, bn, wf, ng), Green River near Big Piney (bn, rb, cc, wf, ng), Green River in Seedskaadee Wildlife Refuge (bn, rb, rc wf, ng).
SG-CC	LaBarge Creek (cc, rb, bk, bn, wf, ng), Fontenelle Creek (rb, cc, bk, bn, wf, ng), Slate Creek (ng, bn),
CS-BM	Dry Piney Creek (cc, bk, limited)
CS-WDB	Dry Piney Creek (cc,bk, limited) Green River (bn, rb, cc, wf, ng), Big Sandy River (bn, rb, ng) Jensen Wash (ng)
SP-WDB-SL	Fogarty Creek (cc, bk), Dry Piney Creek (cc, bk), LaBarge Creek (cc, rb, bk, bn, wf, ng), Fontenelle Creek (rb, cc, bk, bn, wf, ng), Slate Creek (ng, bn).
C-CC	Black's Fork near Granger (ng)
<u>Buckhorn Alternative</u>	
SG-BH-Q	Green River just below South Piney Creek (bn, rb, cc, wf, ng)
SG-BH-W	Green River just below South Piney Creek (bn, rb, cc, wf, ng)
SG-CC	Same as proposed action
CS-WDB	Same as proposed action
CS-BH	Big Sandy River (bn, rb, ng)
SP-1	Same as SP-WDB-SL of proposed action
SP-BH	Green River near SG-BH crossing (bn, rb, cc, wf, ng)
C-CC	Black's Fork near Granger (ng)

TABLE 1-11 (CONTINUED)

Linear Facility	Stream Crossed (Associated Game Fish)
<u>Shute Creek Alternative</u>	
SG-BH-W	Same as SG-BH-W in Buckhorn Alternative
SG-BH-Q	Same as SG-BH-Q in Buckhorn Alternative
SG-SC	LaBarge Creek (bn, rb, cc, bk, wf, ng), Fontenelle Creek (bn, rb, cc, bk, wf, ng), Slate Creek (bn, ng)
SG-CC	Same as SG-SC
CS-BH	Big Sandy River (bg, rb, ng)
CS-SC	Green River in Seedsdakee Wildlife Refuge (bn, rb, cc, wf, ng)
C-CC	Blacks Fork near Granger (ng)
SP-BH	Green River below South Piney Creek (bn, rb, cc, wf, ng)
SP-1	LaBarge Creek (bn, rb, bk, cc, wf, ng), Fontenelle Creek (bn, rb, bk, cc, wf, ng), Slate Creek (bn, ng)
<u>Northern Alternative</u>	
CS-WDB (CS-1, CS-2, CS-3)	Same as proposed action
SG-BH-Q	Green River (same as SG-BH-Q and SG-BH-W of Buckhorn Alternative)
SG-BH-W	Green River (same as SG-BH-Q and SG-BH-W of Buckhorn Alternative)
CS-BH	Same as Buckhorn Alternative
SP-WDB-SL	Same as proposed action
SP-BH	Same as Buckhorn Alternative

¹This list does not contain sour gas line crossings on the well field, which are presented in Figure 2-1.

²See Appendix A of the Wildlife Technical Report for an explanation of abbreviations used for project components in technical report summary tables.

³For fishery resources: cc = Colorado River cutthroat; bk = brook trout; rb = rainbow trout; bn = brown trout; wf = mountain whitefish; ng = nongame species (sucker/minnow)

population (from the Green River). Fontenelle Creek and LaBarge Creek both support resident game and non-game fish species. Game fish include rainbow, brown, brook, and cutthroat trout, and whitefish. Non-game fish are suckers, minnows, and sculpin. Dry Piney Creek frequently goes dry in the lower section and does not support a fishery. Two sour gas trunk lines (SG-BH-Q and SG-BH-W) associated with the Buckhorn Alternative would cross the Green River just below the confluence with South Piney Creek. The Green River near this location contains a good fishery consisting largely of brown trout, rainbow trout, and mountain whitefish. Numerous non-game species also inhabit this reach of the Green River.

The molten sulfur pipeline (SP-WDB-SL) would cross Fogarty Creek, Dry Piney Creek, and all the off-well field streams crossed by Northwest Pipeline's sour gas (SG-CC) trunk line. The fisheries of the affected streams were discussed in the above paragraph.

The molten sulfur pipeline (SP-BH) associated with the Buckhorn Alternative would cross the Green River near the same area of the sour gas trunk lines (SG-BH-Q and SG-BH-W) discussed above. The affected fisheries resources would also be the same.

A water pipeline (W-CC) associated with Northwest Pipeline's proposed action would withdraw water from the Green River just below Fontenelle Dam and transport it to the Craven Creek Plant site. Information regarding specific intake location (pool, run, riffle) in the Green River, intake design, and other information are not available. The fisheries resources of this reach of the Green River include rainbow and brown trout and numerous non-game species.

A railroad spur to haul sulfur (RR-WDB) is a component alternative for Exxon's proposed action. This railroad would cross South, Middle, and North Piney Creeks and Muddy Creek near their mouths and the Green River about 1 mile upstream of Middle Piney Creek. The railroad would eventually turn south and cross the Green River again in the Seedskaadee Wildlife Refuge. The fisheries resources of the lower reaches of Middle, South, and North Piney Creeks include sculpins, mountain suckers, and longnose dace as well as brown, rainbow, brook, and cutthroat trout and mountain whitefish. Predominant game species in South Piney Creek are rainbow trout and mountain whitefish, while brown trout are dominant in the lower portion of Middle Piney Creek (Remmick 1981). Lower North Piney Creek generally experiences low flows during the summer months due to irrigation. Nonetheless, it contains a diverse game and non-game fishery including brook, rainbow, cutthroat trout (both Colorado River and Snake River), whitefish, sculpins, and mountain suckers. Muddy Creek is intermittent in its lower section, however, in its upper reaches it contains Colorado River cutthroat trout, sculpins, and mountain suckers, with some fish moving into the lower reaches when sufficient flows occur (Remmick 1981). The Green River just upstream of Middle and South Piney Creeks contains a similar fishery to those creeks. The predominant game species is brown trout. The fishery of the Green River in the Seedskaadee Wildlife Refuge consists mainly of rainbow and brown trout with rainbow being most abundant.

In summary, most of area's stream that would be affected by Riley Ridge Project activities contain trout fisheries, and are of moderate to high recreational value. Pure to nearly pure sensitive and rare Colorado River cutthroat trout also inhabit several streams within the project area.

ASSUMPTIONS

The environmental consequences section for fisheries resources is based upon the following assumptions:

- 1) The specific stipulations and general measures recognized in Appendix B of the DEIS including strict erosion control, revegetation, and stream protection guidelines will be enforced by land management agencies.
- 2) New access and upgraded roads would be constructed and maintained year-round in a manner that minimizes long-term excessive erosion. Regardless of stipulated mitigation measures, the sediment yield of the drainage basins affected by well field development, construction, and project components would increase to some extent.
- 3) Reserve pit failure rate would not be greater than one percent over the project life (30 to 40 years).
- 4) Because the project would result in an increased population in Sublette, Sweetwater, and Lincoln Counties, it is assumed that legal and illegal fishing would occur linearly. That is, a 50 percent increase in population would result in a 50 percent increase in both legal and illegal fishing.
- 5) A concentration of the projected overall population increase would occur in Sublette County, especially near Marbleton and Big Piney, because of the construction camps and proximity to the well field.
- 6) Because Colorado River cutthroat trout are the most sensitive fish species in the area (Binns 1977), if habitat protection measures for this species are applied, then habitat for other salmonid species in the area should also be protected.

SIGNIFICANCE CRITERIA

Significance criteria for fisheries include:

- Impacts to fisheries resulting from accidental spills of chemicals are considered significant if changes in water quality exceed Wyoming Department of Environmental Quality (WDEQ) water quality criteria or exceed toxic levels for aquatic life. These criteria were developed to protect aquatic life and were derived from the EPA 1976 Quality Criteria for Water. For example, a sour gas line break resulting in H_2S concentrations greater than 2 $\mu g/liter$ in affected streams is considered significant.

- Impacts to fisheries are considered significant if critical habitats (e.g., spawning areas) are affected by increased sedimentation during critical months of fish use; April to June for cutthroat trout and rainbow trout and September to November for brook trout and brown trout.
- Impacts to fisheries are considered significant if beaver ponds would be removed or lost; beaver ponds provide important habitat to fish during low flow periods and drought years.
- Impacts to fisheries are considered significant if culverts at road crossings create barriers to fish movement; barriers can prevent normal movement of both adult and larval fish, increase predation, limit habitat availability and reproductive success; and ultimately decrease population numbers.
- Impacts to streams currently under special WGF and/or BLM management for Colorado River cutthroat trout are considered significant. Disturbance to or near these streams could degrade existing habitat conditions, increase the risk of illegal fishing pressure, and threaten efforts to establish a natural reproducing population of pure Colorado River cutthroat.
- Indirect impacts caused by human population increases are considered significant if the estimated increases in illegal fishing would be greater than or equal to 15 percent over expected baseline conditions. This significance criteria has been used in previous EISs with no adverse comments (BLM 1983). This increase is also considered significant by WGF biologists since any increase in fishing pressure both legal and illegal would tax the existing enforcement and stocking capabilities of WGF.

PROPOSED ACTION

REGIONAL OVERVIEW

The regional impacts to aquatic resources from the proposed Riley Ridge Project over the three-county area (Sublette, Lincoln, and Sweetwater) would be due primarily to increased sedimentation from project construction and an increased demand for available recreational fishery resources. Water quality and fish habitat would decrease, while recreational fishing pressure would increase. Although siltation mitigation measures may be largely effective, some increase in siltation would still result from the Riley Ridge Project, especially in the well field area (see well field discussion). The increased silt load would mainly affect streams in the Middle and South Piney Creek drainages. The increase in sediment load of the Green River would not be significant with respect to the overall silt load presently carried by the Green River but the increase would be undesirable and, depending on timing or other conditions, could be significant.

SITE SPECIFIC

Well Field

Construction

The major direct impacts to aquatic life during the well field construction period would be loss of habitat because of increased sedimentation/siltation of well field streams. Increased sedimentation would result from surface disturbances from the construction of access roads, well pads, pipelines, transmission lines, and other facilities associated with the Riley Ridge Project (Table 2-1). Over 500 miles of new access roads, gathering pipeline corridors, and sour gas trunk line corridors would be constructed during the proposed well field development. These activities and especially road construction, create erosion planes, which collect runoff water and eventually channelize the flow, laden with silt, into adjacent streams. Increased erosion from disturbed areas (3,968 acres) would increase the amount of sediment available to streams draining these areas until successful reclamation stabilized eroding soils (1 to 2 years). Siltation would continue to be a "chronic" effect over the 30-year project life since surface disturbances would continue as new wells were developed. Effects of past sedimentation are evident in lower Pine Grove and Fogarty Creeks where accidental reserve pit spills and inadequate erosion control have occurred. Pine Grove Creek is rated as having one of the worst channel stability ratings in the Rock Springs District because of intensive use by livestock, impacts of oil and gas development, and loss of riparian habitat (BLM 1978). It is currently under BLM management for erosion control and contains two exclosure areas.

The adverse effects of erosion and siltation on all trophic levels of aquatic life have been documented by many investigators. According to Cordone and Kelley (1961), erosion is probably the most insidious of three major contributors to habitat loss (dam construction, pollution, and erosion). Shaw and Maga (1943) distinguished between natural erosion and unnatural erosion. Natural erosion of undisturbed areas is accompanied by streamflows which are sufficient to prevent adverse deposition of suspended sediment in the stream channel. Unnatural erosion, however, occurs when disturbed lands yield sediment during periods of low or moderate streamflows. During periods of low or moderate flow, the streams do not have the velocity and turbulence to carry excess fine sediments away; so they are slowly deposited on the stream bottom. Unnatural erosion would most likely occur during summer and fall and would have the greatest potential of affecting the spawning and egg incubation of brook trout and brown trout. If spring flushing flows are inadequate to sufficiently remove accumulated silt, then spawning of Colorado River cutthroat and rainbow trout may be adversely affected.

In the Riley Ridge well field area increased erosion could affect stream ecosystems by disrupting migration, spawning activities, and egg incubation of Colorado River cutthroat trout and other trout species that are known to exist in the area. Spawning habitat could be silted-in and rendered useless. Silted-in substrates would be incapable of supporting a sufficient macroinvertebrate food base for trout. Microhabitat cover for young trout

TABLE 2-1

NUMBER OF ACRES DISTURBED BY COMPONENT FOR THE PROPOSED ACTION

	Construction	Reclaimed	Operation	Reclaimed	Abandonment ¹
Well Field					
Well Sites	1,102	658	444	444	0
Gathering System	2,109	2,109	0	0	0
Access Roads ²	757	0	757	151	606
Plant Sites	2,800	0	2,800	2,800	0
Corridors					
Railroad ³	85	64	21	8	13
Pipelines ⁴	4,790	4,685	105	105	0
Transmission Line	1,182	1,182	0	0	0
Access Roads	27	0	27	5	22
TOTAL	12,852	8,698	4,154	3,513	641

¹Represents the number of acres of disturbance that would not be reclaimed after the project is abandoned. Included here are facilities that would continue in use after project abandonment, or are infeasible to reclaim.

²Many existing roads would only require upgrading; thus, new disturbance would be less than total land requirement. It is assumed that 80 percent of the project road system would remain in use after project abandonment.

³It is assumed that the operational right-of-way would be 25 feet wide and that a 15-foot wide portion of the right-of-way would be infeasible to reclaim upon project abandonment.

⁴It is assumed that the sulfur pipeline would require a 15-foot wide strip for an access trail during project operation.

would be lost, forcing young trout to live in the open where they would be exposed to predation and more severe environmental conditions. Beaver ponds, which are of utmost importance for trout for survival during low flow and drought periods, could be prematurely silted-in, thus reducing habitat value and causing possible loss of system flow.

The amount of available eroded material and its effects on the stream are difficult to quantify. Inadequate data are currently available to evaluate capacity of the well field streams to transport additional sediment. In addition, construction would occur continually over the project life and mechanical erosion control and revegetation would be used to stabilize eroding soils.

In order to evaluate the potential impacts to streams and fisheries from surface disturbance, a worst-case analysis was conducted for a typical stream with steep slopes, sensitive aquatic resources, and extensive new surface disturbance planned in its drainage, North Fork Beaver Creek. The method developed by Leaf (1974) was used to calculate potential eroded material made available to the stream. Assuming all potential eroded material would reach the stream (no erosion control) and 73 percent of the sediment would be deposited and 27 percent of the sediment would be suspended (fine clay particles), the following calculations were made (see Appendix C for Methodology). Additional eroded material, deposited sediment and suspended sediment attributable to the project was 838 cubic feet/year, 612 cubic feet/year (0.07 inches deposited) and 226 cubic feet/year (2.9 parts/million), respectively, for the first year following construction. Over the next few years the numbers would decrease by about 8 percent each year. This appears to be a small amount of material and given that erosion control measures would be implemented, actual numbers would likely be less. However, sediment input could be greater than predicted by the model which was developed for use by the logging industry in Idaho forests. These forest soils, if coarse and well drained, would probably yield less eroded material than the predominantly sagebrush environment in the Riley Ridge well field. It is not possible to predict the impact of this degree of sedimentation because the baseline characteristics are not known at this time. If this represents a small increment relative to existing quantities being transported and deposited, impacts to spawning gravels would probably be minimal. However, if the increment is large relative to the existing quantities being transported and deposited, deposition of sediment, changes in channel configurations, and filling in of spawning gravels are possible over time. If this were the case, impacts to fisheries could be significant. Miles of stream habitat could potentially be affected by silting in of spawning gravel, premature silting in of natural pools and beaver ponds, and reductions in productivity and available food sources. Certain smaller streams in the southern part of the well field would be the most susceptible because cover on these watersheds is predominantly sagebrush which does not trap sediment as well as forested or grassland communities. Pine Grove Creek, for example, has been affected by surface disturbances (primarily grazing) and oil and gas development in its drainage, and biologists in the region have noted marked changes in the stream habitat and fisheries. Pine Grove Creek currently supports a hybrid Colorado River cutthroat trout fishery and is currently under BLM management for habitat improvement (BLM 1978).

Toxic materials that could enter streams through accidental spills during construction include diesel fuel, oil, drilling muds, and gasoline, and could result in the killing of fish and macroinvertebrates. The probability of an accidental spill is not quantifiable; but the effects of a spill could be significant. For example, a gasoline spill in a stream in South Dakota caused the immediate death of most of the benthic organisms and numerous fish, many of which were native trout (Bugbee and Walter 1973). Accidental introduction of drilling muds through reserve pit failure may or may not cause toxic effects depending on mud composition and the quantity introduced. At low concentrations (1-1,000 microliters/liter), drilling fluids attract whitefish and rainbow trout. The lethal concentration (LC₅₀) for whitefish is 25,000 microliters/liter; while for rainbow trout, it is 75,000 microliters/liter (Ferrante 1981). A spill during the drilling of an oil well in 1972 polluted Pine Grove Creek killing most of the fish stocked the previous year. Pine Grove Creek was impacted again in 1978 by a reserve pit in the Tip Top Unit that failed during a heavy precipitation event. No mortalities were noted; however, at least 2 miles of stream habitat were severely impacted because of siltation (Remmick 1981). Reserve pit failure rate of 1.5 percent over 30 years has been reported in other well fields (BLM 1980). If 238 wells are to be drilled, then the number of reserve pit failures would be 3.6 over the life of the project.

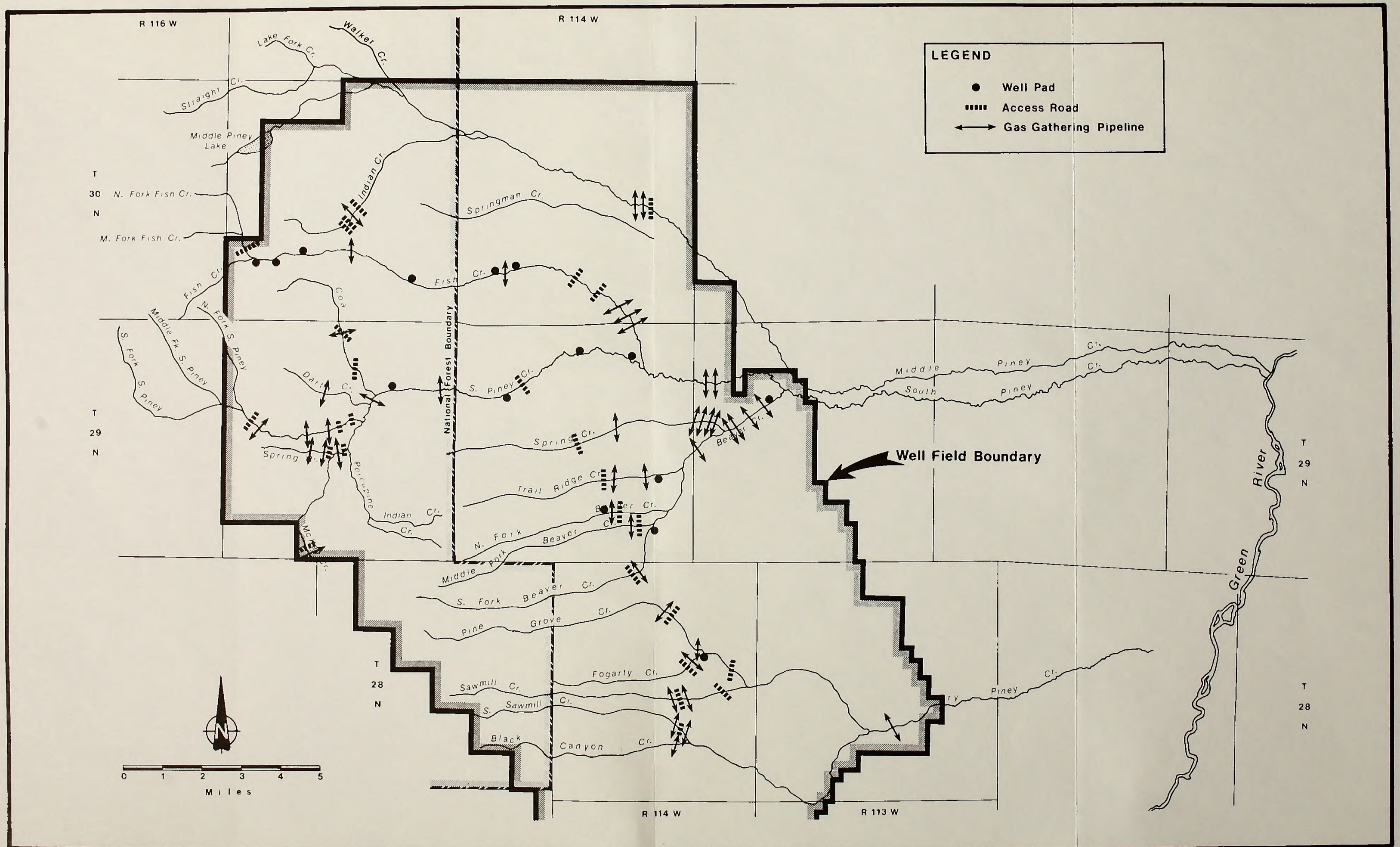
A review of the well field area construction plans indicates the potential for disturbance through sedimentation and accidental spills to nearly all streams. Map 2-1 shows the proposed locations of sour gas pipeline stream crossings, access road corridors, and the proposed locations of well pad sites that are near streams.

The Pinedale Resource Area MFP states that well pads must be placed at least 0.25 mile from stream banks or riparian zones. At this distance most eroding sediment is trapped in the vegetated buffer zone. However, many pads located in steep valleys would likely be constructed near stream banks since offsetting pads 1,300 feet would increase surface disturbance from cut-and-fill slopes.

Flow regimes of the streams could be temporarily altered by taking surface water for drilling make-up water. All applicants plan to use surface water except Exxon. However, water sources other than the Green River have not been identified. Water not pumped from nearby sources would be trucked in from permitted sources usually on private land.

Drilling activities during well field construction may disrupt alluvial and groundwater aquifer flows. The impacts of altered flows would be most significant if small headwater streams and streams south of South Piney Creek (Spring Creek to Dry Piney Creek) were affected. If flow alteration results in abnormally reduced flows, especially during drought years, headwater reaches of streams could be rendered unsuitable for spawning and egg incubation. Reduced flows could also lower the carrying capacity of trout overwintering habitat such as pools, holes, and beaver ponds resulting in reduced populations in the following year.

One of the important streams in the area is North Fork Beaver Creek, which contains one of only a few pure strains of naturally reproducing Colorado River cutthroat trout populations in the Westside Tributaries Enclave. This



MAP 2-1 LOCATION OF PROPOSED ACCESS ROADS AND GAS GATHERING PIPELINE STREAM CROSSINGS, AND WELL PADS NEAR RIPARIAN ZONES

stream currently contains a migration barrier maintained by the BLM near its mouth to prevent upstream movement by other trout species. Proposed project activities in this drainage include: one gas gathering pipeline, a new access road, and a well pad near the stream. These activities would occur in the stream's lower reach or within about 1.5 miles up from its mouth. The gas gathering line would run parallel to the stream in this lower reach. The activities listed above could result in increased sedimentation, potential toxic spills, and increased fishing pressure.

Increased sedimentation to streams containing Colorado River cutthroat trout would degrade habitat through loss of spawning and overwintering areas, and loss of food organisms. This would result in a lowered carrying capacity for the affected streams and a reduction of trout populations.

The impact on Colorado River cutthroat trout of a toxic spill would be the loss of a certain number of trout caught in the impact zone downstream of the spill. Magnitude of the loss would depend upon the number of fish present and the concentration of the toxicant(s) in the impact zone.

Increased fishing pressure would result in a direct reduction in the population of Colorado River cutthroat trout. If Colorado River cutthroat trout and other trout populations are reduced below 50 percent, then the population cannot maintain itself through natural recruitment and would be in danger of extinction without augmentation through stocking (Stone 1983, personal communication).

Operation

During operation, siltation would continue to occur but to a lesser extent than during construction because of revegetation and erosion control measures. Modeling results indicate sedimentation would decrease by about 8 percent each year following peak construction. A constant flow of maintenance traffic to the well sites would continue to disturb roads and maintain potential for erosion. Effects of project activities that may occur accidentally include: spillage of toxic wastes or materials into streams; breakage of sour gas gathering lines below a stream bed; and breakage of lines carrying H_2S -laden water from the dehydration process, all of which could result in fish kills. However, the probability of such a breakage is very low, about 0.002/mile/year of pipeline operation. Given this probability, a spill is not predicted for the life of the project.

A major potential secondary impact to the fishery resources during both the construction and operation phases would be reduced fish population due to increased fishing pressure from an increase in the amount of both legal and illegal fishing. Estimates indicate that the human population over the three-county area would increase by 15 percent in 1986. Assuming fishing would increase in a linear relationship, fishing demand would also increase by 15 percent. Recreational fishing in the well field area is expected to increase by 66 percent in 1985 due to the concentration of the human population in that area. For example, the population of the Big Piney-Marbleton area would almost double by 1986, whereas the population of Sweetwater County would grow only about 3 percent.

Cutthroat trout are easily caught and enforcement of regulations, such as WGF's 10-inch take regulation, may be very difficult. The increased fishing pressure resulting from the population growth in the Riley Ridge area would reduce the existing standing crops of trout in the local streams if appropriate management measures are not developed and enforced. Historical observations indicate that when fishermen locate a good population of cutthroat trout, the trout standing crop soon declines to critically low levels because of the vulnerability of cutthroats to angling (Dunning 1982, personal communication). Compliance with the 10-inch length regulation (i.e., all cutthroat 10 inches and less must be returned to the stream) on cutthroat trout would be necessary to preserve the existing cutthroat populations. Any abuse of this special restriction could result in a reduced capability of the cutthroat population to sustain itself in those streams where it has been established.

Traditional WGF efforts in the area have resulted in a gradual increase in self-sustaining rainbow, brook, and brown trout populations. Colorado River cutthroat trout populations are self-sustaining where competition from rainbow trout and brook trout is not significant. Fish harvest (pressure) in South Piney Creek is currently at a level where natural recruitment cannot keep pace with the demand. Therefore, these wild fish populations are augmented with stocking of catchable rainbow trout (Remmick 1983, personal communication). Additionally, fishing pressure in Fish Creek, the southern tributary to South Piney Creek and Dry Piney Creek is near the level of the current wild cutthroat and brook trout populations abilities to self-sustain. Therefore, a 66 percent increase in fishing pressure on these streams would have a significant impact on these trout populations. The impacts would be further reduction of fish numbers that would further limit natural recruitment and require additional stocking. Other impacts would include WGF adding new regulations to control excessive harvest which would require additional enforcement personnel. Current capacity of the state hatcheries is overburdened causing the state to institute a priority stocking system. This situation is further exacerbated by the closing of several federal fish hatcheries. Thus, the WGF may not be able to respond with sufficient stocking to meet the recreational demands for the streams in and near the well field area (Remmick 1983, personnel communication).

The eventual result of project-related habitat deterioration, increased fishing pressure, and poaching may be a reversal of past "gains" in establishing wild trout populations, to a fishery more dependent upon stocking. These impacts in turn would affect the recreational fishing experience and fisheries management plans, and may result in an increased demand on trout hatchery operations.

Abandonment

Assuming that abandoned areas are reclaimed in the manner stipulated and the reclamation is successful, aquatic habitats should not be further affected by abandonment. In addition, fishing pressure should decrease as the worker population declines.

However, enforcement of stipulations and erosion control measures is essential to protect aquatic resources. Failure to do so could significantly affect aquatic resources by contributing to accelerated habitat deterioration and declines in populations of aquatic organisms.

Plant Sites

Construction

The Proposed Action plant site arrangement includes American Quasar at East Dry Basin, Exxon at West Dry Basin and Big Mesa, and Northwest Pipeline at Craven Creek.

Aquatic habitats would not be affected by East Dry Basin, West Dry Basin, and Big Mesa plant site construction because of their general remoteness from flowing streams. The Craven Creek plant site would affect some small tributaries to Craven Creek. These impacts would be increased sedimentation and loss of benthic macroinvertebrates which would be minor because of the limited value of aquatic resources of Craven Creek.

Plant site construction would require a sizable work force, which may concentrate the fishing pressure described previously in certain stream reaches. For example the West Dry Basin camp site is about 1 mile from South Piney Creek.

Exxon's sulfur load-out facility near the Hams Fork River would require 240 acres of land. This disturbance would result in a small increase in sediment runoff to the Hams Fork River. The Hams Fork at this location does not support a game fishery because of degraded habitat conditions (largely due to siltation, dewatering, and excessive temperatures). Additional sedimentation may result in a further decline in populations of non-game fish and aquatic macroinvertebrates.

Operation

Water needs for treatment plants would largely be supplied by drilling wells into the Wasatch Formation. Water lost from this formation, which is generally 500 feet deep, would probably not affect surface flows. Northwest Pipeline proposes to build a water pipeline from the Green River to its Craven Creek site. Its diversion would be 81 acre-feet/year, and result in a depletion of about 0.24 percent of the historically low flow (January 1978, 476 cubic feet/second). A flow reduction of 0.24 percent in the Green River would not be reliably detectable by current stream gaging techniques. A flow reduction of this amount would not affect the fisheries of the Green River. The intake structure for pumping this small amount of water would not impact the fisheries either through impingement or entrainment, because intake flow velocities would be low and at velocities that trout would be able to avoid.

Waste water (contaminated with H_2S) disposal would not affect aquatic resources. After interim storage in waste water accumulation ponds, Exxon plans eventually to inject the waste water into deep wells. Quasar also plans to inject plant waste water into deep wells on the plant site. Deep well injection would be properly permitted as would the waste accumulation ponds. Northwest would dispose of its waste water in a 30-acre evaporation pond that would have no discharge.

Abandonment

Because of planned rehabilitation/revegetation plans, aquatic habitats would not be affected by plant site abandonment.

Linear Facilities

Potential impacts to fisheries resources from corridor construction would result from stream crossings for roads and pipelines. Construction of staging areas and trenching within a stream would increase suspended solids concentrations during the two-week construction crossing period. Also, the sediments within the trench would be disrupted. Precautions would be taken to prevent sediment or toxic materials from entering a stream from completed staging areas.

An increase in suspended solids alters the physical nature of the stream by reducing light penetration and accumulating on the stream bottom as material settles. Benthic macroinvertebrate and periphyton (attached algae) populations may be reduced by physical removal or as sediment interferes with physiological processes or causes mechanical stress (Farnworth et al. 1979). Temporary (occurring only once and lasting for not more than one year) impacts on fish populations include losses of habitat, spawning areas and food sources and/or movement out of the affected area during the period of increased sediment load. All of the above potential impacts should be short-term (one year) provided that staging areas and banks are stabilized through stipulated reclamation and erosion control plans. Deposited sediment would probably remain until a flow event occurs that is sufficient to flush the sediment away. Small amounts of sediment would continue to enter the stream while disturbed staging and crossing areas were becoming stabilized. Stream habitats could take from 2 to 5 years to recover to preconstruction conditions. The above impacts could eliminate a population of fish in a stream if the impact was severe enough and occurred at a critical location or at a critical time.

Another potential temporary impact from construction could be the proposed withdrawal and release of hydrostatic test water. Impacts of withdrawal of water from streams for hydrostatic testing would be similar to those discussed for well field construction activities.

Also, hydrostatic test water would not be routinely discharged to live streams. The State Engineer may require that water be discharged downstream if severe drought conditions exist. Water would be treated prior to discharge to protect aquatic life (Wagner 1983, personal communication).

Operation

Impacts from corridor operation would be associated with a highly improbable (<0.01 break per life of project) pipeline break in a sour gas pipeline or the molten sulfur pipeline such that highly poisonous H_2S or molten sulfur enters a stream. In the event a sour gas pipeline would break under a streambed, hydrogen sulfide (H_2S) could be released into the stream. H_2S is acutely toxic to aquatic life. The extent of the effect of such a break would depend on stream flow, pH, amount of H_2S released, and other variables. However, since H_2S is highly soluble (~4,000 milligrams/liter) and the EPA's standard for H_2S is 2 micrograms/liter, toxic effects could be experienced for a considerable distance downstream.

Molten sulfur spilled from a pipeline rupture would heat the water locally, causing temperature stress in aquatic organisms immediately below the pipeline. Depending on severity of heat stress, aquatic invertebrates and

fish within the immediate zone of impact could be severely stressed or be immediately killed. Sulfur would crystallize (or solidify) and coat the stream bottom below the spill. Elemental sulfur is not toxic and would not exert any toxic effect on aquatic organisms. Benthic communities and fish habitat would be radically changed by the sulfur coating and adult fish would probably migrate out of the area for several days. Sulfur drains and earthen containment pits would be located well out of stream flood plain areas. Thus, there would be no impacts to streams from the infrequent draining of sulfur.

Release of methane (CH_4) from a sales or sour gas pipeline, or release of carbon dioxide (CO_2) from a CO_2 pipeline to aquatic environments may affect aquatic organisms by causing fish to avoid the immediate area. Concentrations of CO_2 in excess of 20 milligrams/liter can be harmful to fish in a short period of time (Lagler 1949). Methane does not appear to be harmful to fish (Shelford 1917; Schaut 1939). Concentrations of CH_4 and CO_2 would rapidly dissipate downstream of an underwater pipeline leak as the gaseous compounds escape to the atmosphere. A pipeline leak would block migratory fish movement if it is extended over a long period of time. However, the nature of pipeline ruptures is that they occur over a short period of time since the gas is under pressure and block valves close immediately.

Abandonment

It is assumed that buried pipelines would be left in place after project completion, so no impacts to aquatic resources are anticipated from corridor abandonment.

COMPONENT ALTERNATIVES

Table 2-2 provides a summary of the streams crossed or affected by the various component alternatives. Construction of Exxon's railroad alternative would result in a temporary increase in suspended solids in the Green River downstream from the crossings near Big Piney and Seedskaadee Wildlife Refuge. Spills of molten sulfur from the railroad into the river would not be toxic to aquatic life, but would coat bottom substrates. A spill of great magnitude would be very unlikely. The railroad spur associated with the Shute Creek plant site would not cross any streams; thus, no impacts to aquatic resources would occur.

The transmission line corridors associated with the UP&L route from the Naughton Power Plant would cross the following cold water game fish streams: Hams Fork above Kemmerer, Willow Creek, Fontenelle Creek, and LaBarge Creek (Table 2-2). Impacts due to these crossings would be temporary resulting from increased sedimentation associated with any instream disturbances. Impacts would include loss of benthic invertebrates and possible avoidance of the zone of impact by fish during the period of increased suspended solids loading. Effects on aquatic resources during operation would result from routine maintenance vehicular traffic crossing streams. Impacts would be minimal, short-term, and insignificant.

The BLM transmission line route would cross the Hams Fork River directly east of the Naughton Power Plant, Fontenelle Creek, and LaBarge Creek. Impacts to aquatic resources would be minimal as described for the UP&L transmission line route.

TABLE 2-2

STREAMS AND FISHERY RESOURCES AFFECTED BY LINEAR FACILITIES
COMPONENT ALTERNATIVES

Streams	Sulfur Transport		UP&L Transmission Lines				BLM Transmission Lines			
	WDB	SC	PA	BH	SC	NA	PA	BH	SC	NA
Muddy Creek ^{1,2}	X									
North Piney Creek ¹	X									
Middle Piney Creek ¹	X									
South Piney Creek ¹	X									
Dry Piney Creek ³			X		X	X	X		X	X
Upper Green River ¹	X			X		X		X		X
LaBarge Creek ¹			X	X	X	X	X	X	X	X
Muddy Creek ⁴			X	X	X	X	X	X	X	X
Fontenelle Creek ¹			X	X	X	X	X	X	X	X
Slate Creek ⁵			X	X	X	X	X	X	X	X
Green River (Seedskadee) ¹	X									
Upper Hams Fork ¹			X	X	X	X				
Hams Fork (Opal) ⁵			X	X						
Lower Hams Fork ¹							X	X	X	X
Willow Creek ¹			X	X	X	X				

Note: WDB = West Dry Basin, SC = Shute Creek, PA = Proposed Action
BH = Buckhorn, NA = Northern Alternative.

¹These streams are Class II cold water game fish streams that generally contain rainbow, brown, brook and cutthroat trout.

²Muddy Creek north of North Piney Creek.

³Does not support a fishery where transmission line crosses.

⁴Muddy Creek between LaBarge and Fontenelle Creeks.

⁵These streams support primarily nongame fish (suckers and minnows) populations.

Depending upon alternative, the UP&L and BLM transmission line routes would also cross different non-trout streams (Table 2-2). Impacts to these streams would be a minimal temporary loss of benthic macroinvertebrates and probably no detectable impacts on the sucker/minnow fish populations which are adapted to high suspended solids conditions.

The four construction camps, would concentrate fishing pressure in the areas around the camps resulting in decreased fish populations. No direct impacts due to sedimentation would occur because of the remoteness of these camps to streams.

BUCKHORN ALTERNATIVE

The Buckhorn Alternative would put Quasar at the Buckhorn plant site, Exxon at East and West Dry Basin, and Northwest Pipeline at Craven Creek. Impacts affecting fishery resources in the well field or plant sites would be the same as those discussed for the Proposed Action.

LINEAR FACILITIES

Construction

Impacts associated with pipeline, road, and transmission line construction would be the same as described for the Proposed Action. Table 2-3 illustrates streams and fishery resources affected by linear facilities for the Buckhorn Alternative. Transmission line, sour gas, and molten sulfur pipeline crossings associated with the Buckhorn plant site would be expected to cause a temporary increase in suspended solids to the Green River during construction causing only moderate short-term impacts. Impacts would be loss of benthic macroinvertebrates through smothering, and reduction of egg hatch success due to egg suffocation during incubation periods. In addition, flow withdrawals for hydrostatic testing may cause a reduction in WUA for juvenile trout.

Operation

Potential impacts are the same as discussed under the Proposed Action except that for the Buckhorn Alternative, 36-inch and 30-inch sour gas trunk lines and a molten sulfur pipeline would cross the Green River about 8 miles south of Big Piney, Wyoming. Leakage or a spill of these substances would cause a fish kill and degradation of the habitat and aquatic community of the Green River (see discussion under Proposed Action). However, given the probability of a pipeline rupture at a stream crossing (0.0022/mile/year), a rupture is not likely to occur over the 30-year project life.

Abandonment

No impacts to aquatic resources are anticipated due to abandonment.

SHUTE CREEK ALTERNATIVE

The Shute Creek Alternative would locate Quasar at the Buckhorn plant site, Exxon at Shute Creek, and Northwest Pipeline Company at Craven Creek. No additional impacts are expected to affect fishery resources in the well field or at the plant sites.

TABLE 2-3

STREAMS AND FISHERY RESOURCES AFFECTED BY LINEAR
FACILITIES FOR THE BUCKHORN ALTERNATIVE

Streams	Sulfur Pipeline	Transmission Lines	Sour Gas Pipeline	Sales Gas & CO ₂ Pipeline
North Piney Creek ¹				
Middle Piney Creek ¹				
South Piney Creek ⁽¹⁾				
Dry Piney Creek ²	X		X	X
Upper Green River ¹	X	X	X	X
La Barge Creek ⁽¹⁾	X	X	X	
Muddy Creek ⁽³⁾	X	X	X	
Fontenelle Creek ⁽¹⁾	X	X	X	
Slate Creek ⁽³⁾	X	X	X	
Green River (Seeds-kadee) ¹				X
Hams Fork (Opal) ¹		X		
Willow Creek ¹				
Alkali Creek ⁴		X		
Bitter Creek ⁴				X
Jensen Wash ⁽³⁾				X
Big Sandy River ¹				X
Blacks Fork ¹				X

¹These streams are Class II cold water game fish streams that generally contain rainbow, brown, brook and cutthroat trout. Parenthesis () indicates stream is not officially classified but supports a fishery similar to that indicated by the footnote number.

²Dry Piney Creek near crossings supports a marginal trout population.

³These streams are Class III that support primarily nongame fish (sucker and minnows) populations.

⁴These streams may support marginal non-game fisheries or are Class IV streams (incapable of supporting fish).

LINEAR FACILITIES

Construction

Potential construction impacts should be the same as anticipated for the Proposed Action except that the sales gas/CO₂ pipeline from Shute Creek would cross the Green River in the Seedskaadee Wildlife Refuge. Table 2-4 illustrates streams and fisheries affected by linear facilities for the Shute Creek Alternative. A temporary insignificant increase in suspended solids would be expected during construction as long as construction timing did not correspond to critical life cycle activities such as spawning or egg incubation. Impacts would be loss of benthic macroinvertebrates through smothering and a reduction of egg hatch success due to suffocation of eggs.

Operation

Potential impacts should be the same as anticipated for the Proposed Action except that the Green River in the Seedskaadee Wildlife Refuge could be affected by a sales gas or CO₂ pipeline break. Effects of such breaks are discussed under the Proposed Action.

Abandonment

No impacts to aquatic resources are anticipated from abandonment.

NORTHERN ALTERNATIVE

PLANT SITES

All plant sites would be located in the northern end of the project area with Exxon at West Dry Basin and Big Mesa, Quasar at Buckhorn, and Northwest Pipeline at East Dry Basin. The plant site construction, operation, and abandonment activities would not directly affect any aquatic resources. However, due to the concentration of the work force in this area (construction camps and communities), an adverse effect to the game fishery of the streams draining the well field area would be expected. Impacts would be due to increased legal and illegal fishing which would result in the reduction of trout populations below self-sustaining levels and increased demand on fish hatcheries to augment populations through stocking.

LINEAR FACILITIES

This alternative adds no new corridors which would affect any additional aquatic resources. Streams affected by corridors associated with the Northern Alternative are illustrated in Table 2-5.

IMPACT SUMMARY

After a review of historical impacts by oil and gas activities, the potential impacts to the Colorado River cutthroat trout and other aquatic resources affected by the proposed activities of the Riley Ridge Project would be: 1) loss of habitat because of increased stream and beaver pond siltation resulting from over 3,968 acres of land and stream bed disturbances because of the construction and use of roads, well pads, pipelines, and plant sites and 2) reduced fish population due to increased

TABLE 2-4

STREAMS AND FISHERY RESOURCES AFFECTED BY LINEAR
FACILITIES FOR THE SHUTE CREEK ALTERNATIVE

Streams	Sulfur Pipeline	Transmission Lines	Sour Gas Pipeline	Sales Gas & CO ₂ Pipeline
North Piney Creek ¹				
Middle Piney Creek ¹				
South Piney Creek ⁽¹⁾				
Dry Piney Creek ⁽²⁾	X		X	
Upper Green River ¹				
La Barge Creek ⁽¹⁾	X	X	X	
Muddy Creek ⁽³⁾	X			
Fontenelle Creek ¹	X	X	X	
Slate Creek ⁽³⁾	X	X	X	
Green River (Seedskaadee) ¹				X
Hams Fork (Opal) ³		X		
Willow Creek ¹		X		
Alkali Creek ⁴		X		
Big Sandy River ¹				X
Jensen Wash ⁽³⁾				X
Bitter Creek ⁴				X
Blacks Fork ¹				X

¹These streams are Class II cold water game fish streams that generally contain rainbow, brown, brook and cutthroat trout. Parenthesis () indicates stream is not officially classified but supports a fishery similar to that indicated by the footnote number.

²Dry Piney near crossings supports a marginal trout population.

³These streams are Class III that support primarily nongame fish (sucker and minnows) populations.

⁴These streams support marginal non-game fisheries or are Class IV streams (incapable of supporting fish).

TABLE 2-5

STREAMS AND FISHERY RESOURCES AFFECTED BY LINEAR
FACILITIES FOR THE NORTHERN ALTERNATIVE

Streams	Sulfur Pipeline	Transmission Lines	Sour Gas Pipeline	Sales Gas & CO ₂ Pipeline
North Piney Creek ¹				
Middle Piney Creek ¹				
South Piney Creek ⁽¹⁾				
Dry Piney Creek ²	X		X	X
Upper Green River ¹	X	X	X	X
LaBarge Creek ⁽¹⁾	X	X		
Muddy Creek ⁽³⁾				
Fontenelle Creek ⁽¹⁾	X	X		
Slate Creek ⁽³⁾	X	X		
Upper Hams Fork ¹				
Hams Fork (Opal) ³		X		
Willow Creek ¹				
Alkali Creek ⁴		X		
Bitter Creek ⁴				X
Jensen Wash ⁽³⁾				X
Big Sandy River ¹				X
North Fork Dry Piney Creek ⁴	X			

¹These streams are Class II cold water game fish streams that generally contain rainbow, brown, brook and cutthroat trout. Parenthesis () indicates stream is not officially classified but supports a fishery similar to that indicated by the footnote number.

²Dry Piney Creek near crossings supports a marginal trout fishery.

³These streams are Class III that support primarily nongame fish (sucker and minnows) populations.

⁴These streams may support marginal fisheries or are Class IV streams (incapable of supporting fish).

fishing pressure (both legal and illegal). Less probable events that would impact fisheries are: 1) sour gas pipeline ruptures that could release highly toxic H_2S into streams, 2) failure or leakage of reserve pits that would contaminate surface water, 3) molten sulfur pipeline breakage that could affect stream habitats, and 4) stream flow alterations from potential disruption of alluvial groundwater flows, withdrawals for well drilling, and pipeline hydrostatic testing activities.

Because of planned project construction, operation, and abandonment mitigative procedures and government stipulations, potential significant impacts would be substantially reduced. However, regardless of mitigation measures, stream and beaver pond siltation can be expected to increase, as would recreational and illegal fishing. The effects of siltation would generally occur over a long period of time. Chronic siltation would contribute to habitat degradation in streams already experiencing sedimentation problems (especially those in the southern portion of the well field). Increased siltation may render these marginal streams incapable of supporting trout. Increases in fishing pressure and abuse of the 10-inch creel regulation for Colorado River cutthroat could reduce population densities and severely limit natural recruitment if management is ineffective.

The streams affected by road and corridor crossings would be impacted for a short time (generally less than one year). Accidental entry of H_2S into a stream, although very unlikely, would have a severe acute impact on fisheries with fish kills of major proportions possible. Failure of a reserve pit, especially during a significant precipitation event would seriously impact fisheries resources both acutely and over the long term as evidenced by the Pine Grove Creek (Tip Top unit) spill events in 1972 and 1978. The 1972 spill occurred soon after WGF had stocked 1,150 Colorado River cutthroat trout, most of which were killed. Breakage of a molten sulfur pipeline over a stream would not have a direct toxic effect, but molten sulfur would briefly heat the water and quickly solidify, covering substrates and rendering them uninhabitable by benthic organisms for a long period of time. Drilling activities may cause disruption of alluvial and groundwater flow patterns and may cause localized reductions in stream flow and the degradation of water quality, thus reducing fishery habitat quality.

Overall, the project presents the possibility of adversely affecting streams, mainly in the well field area where activity would be intensive and valuable resources are present. Increased long-term siltation coupled with increased fishing pressure, altered stream flows, and a few accidental spills could create sufficient stress on the existing fishery to reduce its future value.

A literature review and site visit was conducted to obtain regional and site-specific information on the aquatic resources. Books, journals, technical reports, Wyoming Game and Fish Department (WGF) data files and interviews provided pertinent information. Experts contacted regarding this project are listed in the References section.

Twelve stations were selected on 10 streams within the well field area to survey the macroinvertebrate communities and to conduct Habitat Quality Index (HQI) and instream flow surveys (Map 1-1). Each station was established in a representative portion of the stream in order to characterize stream habitat. Stations were established in stream reaches that were downstream of proposed development in order to provide baseline data for impact assessment and future monitoring studies. Stations were also selected to coincide with previous WGF HQI transects and to satisfy the requirements of HQI and ISF methodologies. Both the HQI and instream flow methodologies require free-flowing water; therefore, streams with an abundance of beaver ponds were sampled at an available stretch of flowing water.

The use of macroinvertebrates as indicators of water quality and habitat conditions has increased during the past 20 years, such that it is now an important component of most aquatic community studies. Macroinvertebrates were collected in August 1982 from riffles at each station (except FG-2) with a Surber square-foot stream bottom sampler (240 μ /m mesh netting). Three replicate samples were collected at each station. Samples were preserved with 10 percent formalin and transported to the ERT laboratory for analysis. In the laboratory, organisms were sorted from debris and identified to the lowest practical level using the following references: Allen and Edmunds 1962, 1963, 1965; Baumann et al. 1977; Beck 1976; Edmundson 1959; Edmunds and Allen 1964; Edmunds et al. 1976; Hiltunen and Klemm 1980; Holsinger 1976; Johnson 1978; Mason 1973; Merritt and Cummins 1978; Parrish 1975; Pennak 1978; Smith 1968; Szczytko and Stewart 1979; Usinger 1956; White 1978; and Wiggins 1977.

Mean diversity ($\bar{d}$) and equitability (e) values were calculated for macroinvertebrates at each station using formulae and tables given by Weber (1973).

HQI procedures were used to measure the physical, chemical, and biological characteristics of representative reaches within each stream and to predict trout standing crop. Parameters measured at each station included late summer flow, annual flow variation, maximum stream temperature, nitrate-nitrogen, abundance of fish food, cover, bank stability, substrate type, water velocity, and stream width. Measurements were taken during August and September 1982 in accordance with procedures in Binns (1979). Data from each sampling station were then inserted into a regression model (Model II) that predicts trout standing crop (pounds/acre) from measurements of the variables listed above (Binns 1979).

The objective of the instream flow analysis was to quantify, to the extent possible, the effect of flow changes on the aquatic habitat available to various life stages of Colorado River cutthroat trout. The cutthroat trout was selected for the instream flow analysis because of its sensitive status compared to other trout species (e.g., rainbow). It was assumed that the results of this instream flow analysis could be used as guidelines for protecting all trout. Of the physical parameters measured using instream flow analysis, flows are particularly important to quality and quantity of fish habitat. Current was measured with a Marsh McBirney or Gurley Pigmy Current Meter. Hydrologic/biologic computer simulation was conducted to evaluate effects of specific incremental changes in discharge on the habitat of different life stages of cutthroat trout in the 10 selected streams. The simulation used was the incremental methodology developed by the Cooperative Instream Flow Service Group (IFG) of the Fish and Wildlife Service, called the Physical Habitat Simulation System (PHABSIM). Hydraulic and instream habitat conditions were measured according to established methodology (Trihey and Wegner 1981). The IFG model requires cross-sectional stream depth, current and substrate data from each stream reach under study. All measurements were taken in the field during September 1982. Ideally, these measurements should be taken at three different flows (i.e., high flow, medium flow and low flow); therefore, results of this study should be interpreted with caution.

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1. Date of Survey: _____
2. Name of Surveyor: _____
3. Name of Site: _____

4. Location of Site: _____
5. Name of Landowner: _____

6. Name of Surveyor: _____
7. Name of Site: _____
8. Name of Landowner: _____

9. Name of Surveyor: _____
10. Name of Site: _____
11. Name of Landowner: _____

APPENDIX A
HABITAT QUALITY INDEX (HQI)
FIELD DATA FORMS

12. Name of Surveyor: _____
13. Name of Site: _____
14. Name of Landowner: _____
15. Name of Surveyor: _____
16. Name of Site: _____
17. Name of Landowner: _____

18. Name of Surveyor: _____
19. Name of Site: _____
20. Name of Landowner: _____
21. Name of Surveyor: _____
22. Name of Site: _____
23. Name of Landowner: _____

EXHIBIT 1

STATE OF NEW YORK

IN SENATE

HABITAT QUALITY INDEX (HQI) DATA FORM

Stream: South Piney Ck. SP-2 Location: Above Snider Basin
 Date Data Collected: 9/17/92 HQI Score = 88 = Lbs/Acre
 Trout Standing Crop: _____ Lbs/Acre 95 Trout Habitat Units

ATTRIBUTE (Symbol)	DATA	RATING
(X ₁) Late Summer Flow		3
(X ₂) Annual Flow Variation		3
(X ₃) Maximum Summer Stream Temperature	_____ °C	3
(X ₄) Nitrate Nitrogen	<u>< 0.02</u> mg/l	1
(X ₅) Fish Food Abundance	_____ Organisms/ Square Foot	
(X ₆) Fish Food Diversity	Ds = _____	
(X ₇) Cover	<u>21.5</u> % of Total Area	1
(X ₈) Eroding Stream Banks (Bank Stability)	<u>20.3</u> %	3
(X ₉) Substrate	<u>489</u> / ft ²	3
(X ₁₀) Water Velocity	<u>1.38</u> Ft/Sec	3
(X ₁₁) Stream Width	<u>16.3</u> Feet	3

5240 / m²

$$F = (X_3)(X_4)(X_9)(X_{10}) = (3)(1)(3)(3) = \underline{27}$$

$$S = (X_7)(X_8)(X_{11}) = (1)(3)(3) = \underline{9}$$

$$\log_{10} (\hat{Y}+1) = [(-0.903) + (0.807) \log_{10} (X_1+1) + (0.877) \log_{10} (X_2+1) + (1.233) \log_{10} (X_3+1) + (0.631) \log_{10} (F+1) + (0.182) \log_{10} (S+1)] [1.12085] = \underline{1.9484}$$

$$\hat{Y} = \text{antilog}_{10} \underline{1.9484} (1.12085) - 1.0 = \underline{\quad\quad\quad} \text{ kg/hectare}$$

84.4 - 1.0 = 88 lbs/acre

HABITAT QUALITY INDEX (HQI) DATA FORM

Stream: South Beaver ck Location: SB-1
 Date Data Collected: 9/18/82 HQI Score = 15 = Lbs/Acre
 Trout Standing Crop: _____ Lbs/Acre 16 Trout Habitat Units

ATTRIBUTE (Symbol)	DATA	RATING
(X ₁) Late Summer Flow		2
(X ₂) Annual Flow Variation		2
(X ₃) Maximum Summer Stream Temperature	_____ °C	2
(X ₄) Nitrate Nitrogen	<u>40.04</u> mg/l	1
(X ₅) Fish Food Abundance	_____ Organisms/ Square Foot	
(X ₆) Fish Food Diversity	Ds = _____	
(X ₇) Cover	<u>21.3</u> % of Total Area	1
(X ₈) Eroding Stream Banks (Bank Stability)	<u>41.6</u> %	2
(X ₉) Substrate	<u>175</u> /ft ²	2
(X ₁₀) Water Velocity	<u>0.58</u> Ft/Sec	2
(X ₁₁) Stream Width	<u>7.1</u> Feet	2

1880 /m²

$$F = (X_3)(X_4)(X_9)(X_{10}) = (2)(1)(2)(2) = 8$$

$$S = (X_7)(X_8)(X_{11}) = (1)(2)(2) = 4$$

$$\log_{10} (\hat{Y}+1) = [(-0.903) + (0.807) \log_{10} (X_1+1) + (0.877) \log_{10} (X_2+1) + (1.233) \log_{10} (X_3+1) + (0.631) \log_{10} (F+1) + (0.182) \log_{10} (S+1)] [1.12085] = 1.217$$

$$\hat{Y} = \text{antilog}_{10} \frac{1.217 (1.12085) - 1.0}{16.} = \text{kg/hectare}$$

- 1.0 = 15 lbs/acre

HABITAT QUALITY INDEX (HQI) DATA FORM

Stream: Beaver Creek Location: B-1
 Date Data Collected: 1/20 HQI Score = 35 = Lbs/Acre
 Trout Standing Crop: _____ Lbs/Acre 37 Trout Habitat Units

ATTRIBUTE (Symbol)	DATA	RATING
(X ₁) Late Summer Flow		2
(X ₂) Annual Flow Variation		2
(X ₃) Maximum Summer Stream Temperature	<u>10.5</u> °C	3
(X ₄) Nitrate Nitrogen	<u><0.02</u> mg/l	1
(X ₅) Fish Food Abundance	_____ Organisms/ Square Foot	
(X ₆) Fish Food Diversity	Ds = _____	
(X ₇) Cover	<u>55.5</u> % of Total Area	4
(X ₈) Eroding Stream Banks (Bank Stability)	<u>54.8</u> %	1
(X ₉) Substrate	<u>238</u> /ft ²	2
(X ₁₀) Water Velocity	<u>.79</u> Ft/Sec	2
(X ₁₁) Stream Width	<u>13.4</u> Feet	3

2562 /m²

$$F = (X_3)(X_4)(X_9)(X_{10}) = (3)(1)(2)(2) = \underline{12}$$

$$S = (X_7)(X_8)(X_{11}) = (4)(1)(3) = \underline{12}$$

$$\log_{10} (\hat{Y}+1) = [(-0.903) + (0.807) \log_{10} (X_1+1) + (0.877) \log_{10} (X_2+1) + (1.233) \log_{10} (X_3+1) + (0.631) \log_{10} (F+1) + (0.182) \log_{10} (S+1)] [1.12085] = \underline{1.548}$$

$$\hat{Y} = \text{antilog}_{10} \frac{1.548}{35} (1.12085) - 1.0 = \underline{\hspace{2cm}} \text{ kg/hectare}$$

35 - 1.0 = 34 lbs /acre.

HABITAT QUALITY INDEX (HQI) DATA FORM

Stream: Pine Grove Creek Location: ^{BLM} upper enclosure P6-1
 Date Data Collected: 9/10/82 HQI Score = 16 = Lbs/Acre
 Trout Standing Crop: 17 Lbs/Acre 17 Trout Habitat Units

ATTRIBUTE (Symbol)	DATA	RATING
(X ₁) Late Summer Flow		2
(X ₂) Annual Flow Variation		1
(X ₃) Maximum Summer Stream Temperature	<u>12</u> °C	3
(X ₄) Nitrate Nitrogen	<u>4.02</u> mg/l	1
(X ₅) Fish Food Abundance	_____ Organisms/ Square Foot	
(X ₆) Fish Food Diversity	Ds = _____	
(X ₇) Cover	<u>15.2</u> % of Total Area	1
(X ₈) Eroding Stream Banks (Bank Stability)	<u>20</u> %	3
(X ₉) Substrate = food abundance	<u>244</u> / ft ²	3
(X ₁₀) Water Velocity	<u>0.34</u> Ft/Sec	1
(X ₁₁) Stream Width	<u>5.1</u> Feet	1

3061 / m²

$$F = (X_3)(X_4)(X_9)(X_{10}) = (3)(1)(3)(1) = 9$$

$$S = (X_7)(X_8)(X_{11}) = (1)(3)(1) = 3$$

$$\log_{10} (\hat{Y}+1) = [(-0.903) + (0.807) \log_{10} (X_1+1) + (0.877) \log_{10} (X_2+1) + (1.233) \log_{10} (X_3+1) + (0.631) \log_{10} (F+1) + (0.182) \log_{10} (S+1)] [1.12085] = 1.226$$

$$\hat{Y} = \text{antilog}_{10} \frac{1.226}{17} (1.12085) - 1.0 = \text{_____ kg/hectare}$$

17 - 1.0 16 lbs/acre

HABITAT QUALITY INDEX (HQI) DATA FORM

Stream: Fogarty Cr Location: FG-1
 Date Data Collected: 9/20/82 HQI Score = 19 = Lbs/Acre
 Trout Standing Crop: _____ Lbs/Acre 20 Trout Habitat Units

ATTRIBUTE (Symbol)	DATA	RATING
(X ₁) Late Summer Flow		2
(X ₂) Annual Flow Variation		2
(X ₃) Maximum Summer Stream Temperature	<u>9</u> °C	2
(X ₄) Nitrate Nitrogen	<u>0.02</u> mg/l	1
(X ₅) Fish Food Abundance	_____ Organisms/ Square Foot	
(X ₆) Fish Food Diversity	Ds = _____	
(X ₇) Cover	<u>47.1</u> % of Total Area	3
(X ₈) Eroding Stream Banks (Bank Stability)	<u>8.0</u> %	4
(X ₉) Substrate = food abundance	<u>100</u> / Ft ²	2
(X ₁₀) Water Velocity	<u>0.53</u> Ft/Sec	2
(X ₁₁) Stream Width	<u>6.2</u> Feet	1

$$F = (X_3)(X_4)(X_9)(X_{10}) = (2)(1)(2)(2) = \underline{8}$$

$$S = (X_7)(X_8)(X_{11}) = (3)(4)(1) = \underline{12}$$

$$\log_{10} (\hat{Y}+1) = [(-0.903) + (0.807) \log_{10} (X_1+1) + (0.877) \log_{10} (X_2+1) + (1.233) \log_{10} (X_3+1) + (0.631) \log_{10} (F+1) + (0.182) \log_{10} (S+1)] [1.12085] = \underline{1.2935}$$

$$\hat{Y} = \text{antilog}_{10} \frac{1.2935 (1.12085) - 1.0}{19.6} = \underline{30.6} \text{ kg/hectare}$$

$$- 1.0 = \underline{18.6} \text{ lbs/Acre}$$

1090 / m²

HABITAT QUALITY INDEX (HQI) DATA FORM

Stream: Upper Fogarty Creek Location: FG-2
 Date Data Collected: 9/12/82 HQI Score = 12 = Lbs/Acre
 Trout Standing Crop: _____ Lbs/Acre 13 Trout Habitat Units

ATTRIBUTE (Symbol)	DATA	RATING
(X ₁) Late Summer Flow		2
(X ₂) Annual Flow Variation		2
(X ₃) Maximum Summer Stream Temperature	_____ °C	2
(X ₄) Nitrate Nitrogen	<u>< 0.02</u> mg/l	1
(X ₅) Fish Food Abundance	_____ Organisms/ Square Foot	
(X ₆) Fish Food Diversity	Ds = _____	
(X ₇) Cover	<u>13.2</u> % of Total Area	1
(X ₈) Eroding Stream Banks (Bank Stability)	<u>25.5</u> %	2
* (X ₉) Substrate	<u>284</u> /ft ²	3
(X ₁₀) Water Velocity	<u>0.48</u> Ft/Sec	1
(X ₁₁) Stream Width	<u>3.0</u> Feet	1

$$F = (X_3)(X_4)(X_9)(X_{10}) = (2)(1)(3)(1) = \underline{6}$$

$$S = (X_7)(X_8)(X_{11}) = (1)(2)(1) = \underline{2}$$

$$\log_{10} (\hat{Y}+1) = [(-0.903) + (0.807) \log_{10} (X_1+1) + (0.877) \log_{10} (X_2+1) + (1.233) \log_{10} (X_3+1) + (0.631) \log_{10} (F+1) + (0.182) \log_{10} (S+1)] [1.12085] = \underline{1.108}$$

$$\hat{Y} = \text{antilog}_{10} \frac{1.108}{1.12085} = \frac{(1.12085) - 1.0}{-1.0} = \underline{12} \text{ lbs/acre}$$

for macroinvertebrates

* Upper Fogarty Creek not sampled ^{on} since it is within a mile of FG-1.
 Therefore nearby Pine Grove _{on} used as a substitute

HABITAT QUALITY INDEX (HQI) DATA FORM

Stream: Black Canyon creek BC-1 Location: below road crossing
 Date Data Collected: 9/18/82 HQI Score = 23 = Lbs/Acre
 Trout Standing Crop: _____ Lbs/Acre 25 Trout Habitat Units

ATTRIBUTE (Symbol)	DATA	RATING
(X ₁) Late Summer Flow		3
(X ₂) Annual Flow Variation		2
(X ₃) Maximum Summer Stream Temperature	_____ °C	2
(X ₄) Nitrate Nitrogen	<u>< 0.02</u> mg/l	1
(X ₅) Fish Food Abundance	_____ Organisms/ Square Foot	
(X ₆) Fish Food Diversity	Ds = _____	
(X ₇) Cover	<u>17.2</u> % of Total Area	1
(X ₈) Eroding Stream Banks (Bank Stability)	<u>28.0</u> %	2
(X ₉) Substrate	<u>492</u> /ft ²	3
(X ₁₀) Water Velocity	<u>0.54</u> Ft/Sec	2
(X ₁₁) Stream Width	<u>2.4</u> Feet	1

5297/m²

$$F = (X_3)(X_4)(X_9)(X_{10}) = (2)(1)(3)(2) = \underline{12}$$

$$S = (X_7)(X_8)(X_{11}) = (1)(2)(1) = \underline{2}$$

$$\log_{10} (\hat{Y}+1) = [(-0.903) + (0.807) \log_{10}^4 (X_1+1) + (0.877) \log_{10}^3 (X_2+1) + (1.233) \log_{10}^3 (X_3+1) + (0.631) \log_{10} (F+1) + (0.182) \log_{10} (S+1)] [1.12085] = \underline{1.379}$$

$$\hat{Y} = \text{antilog}_{10} \underline{1.379} (1.12085) - 1.0 = \underline{24} \text{ kg/hectare}$$

- 1.0 = 23

HABITAT QUALITY INDEX (HQI) DATA FORM

Stream: South Fork Middle Piney^{CK} Location: SF-1
 Date Data Collected: 9/19/82 HQI Score = 22 = Lbs/Acre
 Trout Standing Crop: 24 Lbs/Acre Trout Habitat Units

ATTRIBUTE (Symbol)	DATA	RATING
(X ₁) Late Summer Flow		2
(X ₂) Annual Flow Variation		2
(X ₃) Maximum Summer Stream Temperature	<u>7.5</u> °C	2
(X ₄) Nitrate Nitrogen	<u>0.07</u> mg/l	2
(X ₅) Fish Food Abundance	Organisms/ Square Foot	
(X ₆) Fish Food Diversity	Ds =	
(X ₇) Cover	<u>53.7</u> % of Total Area	3
(X ₈) Eroding Stream Banks (Bank Stability)	<u>79.5</u> %	0
(X ₉) Substrate	<u>474</u> /ft ²	3
(X ₁₀) Water Velocity	<u>0.93</u> Ft/Sec	2
(X ₁₁) Stream Width	<u>7.4</u> Feet	2

5108/m²

$$F = (X_3)(X_4)(X_9)(X_{10}) = (2)(2)(3)(2) = 24$$

$$S = (X_7)(X_8)(X_{11}) = (3)(0)(2) = 0$$

$$\log_{10} (\hat{Y}+1) = [(-0.903) + (0.807) \log_{10} (X_1+1) + (0.877) \log_{10} (X_2+1) + (1.233) \log_{10} (X_3+1) + (0.631) \log_{10} (F+1) + (0.182) \log_{10} (S+1)] [1.12085] =$$

$$\hat{Y} = \text{antilog}_{10} \frac{1.37}{23.4} (1.12085) - 1.0 = \text{kg/hectare}$$

- 1.0 = 22 lbs/acre

HABITAT QUALITY INDEX (HQI) DATA FORM

Stream: Fish Creek Location: F 2
 Date Data Collected: 9/19/82 HQI Score = 56 = Lbs/Acre
 Trout Standing Crop: _____ Lbs/Acre 60 Trout Habitat Units

ATTRIBUTE (Symbol)	DATA	RATING
(X ₁) Late Summer Flow		2
(X ₂) Annual Flow Variation		2
(X ₃) Maximum Summer Stream Temperature	<u>4</u> °C	3
(X ₄) Nitrate Nitrogen	<u>0.06</u> mg/l	2
(X ₅) Fish Food Abundance	_____ Organisms/ Square Foot	
(X ₆) Fish Food Diversity	Ds = _____	
(X ₇) Cover	<u>17.9</u> % of Total Area	1
(X ₈) Eroding Stream Banks (Bank Stability)	<u>57.7</u> %	1
(X ₉) Substrate	<u>283</u> /ft ²	3
(X ₁₀) Water Velocity	<u>0.78</u> Ft/Sec	2
(X ₁₁) Stream Width	<u>20.5</u> Feet	4

3042/m²

$$F = (X_3)(X_4)(X_9)(X_{10}) = (3)(2)(3)(2) = \underline{36}$$

$$S = (X_7)(X_8)(X_{11}) = (1)(1)(4) = \underline{4}$$

$$\log_{10} (\hat{Y}+1) = [(-0.903) + (0.807) \log_{10} (X_1+1) + (0.877) \log_{10} (X_2+1) + (1.233) \log_{10} (X_3+1) + (0.631) \log_{10} (F+1) + (0.182) \log_{10} (S+1)] [1.12085] = \underline{1.759}$$

$$\hat{Y} = \text{antilog}_{10} \underline{1.759} (1.12085) - 1.0 = \underline{\hspace{2cm}} \text{ kg/hectare}$$

57.

$$- 1.0 = 56 \text{ lbs/acre}$$

HABITAT QUALITY INDEX (HQI) DATA FORM

Stream: Coal Creek (above snider Basin) Location: C-1
 Date Data Collected: 9/17/92 HQI Score = 21 = Lbs/Acre
 Trout Standing Crop: _____ Lbs/Acre 23 Trout Habitat Units

ATTRIBUTE (Symbol)	DATA	RATING
(X ₁) Late Summer Flow		3
(X ₂) Annual Flow Variation		3
(X ₃) Maximum Summer Stream Temperature	_____ °C	2
(X ₄) Nitrate Nitrogen	<u>< 0.02</u> mg/l	1
(X ₅) Fish Food Abundance	_____ Organisms/ Square Foot	
(X ₆) Fish Food Diversity	Ds = _____	
(X ₇) Cover	<u>59.5</u> % of Total Area	4
(X ₈) Eroding Stream Banks (Bank Stability)	<u>11.2</u> %	3
(X ₉) Substrate	<u>72</u> /ft ²	1
(X ₁₀) Water Velocity	<u>0.63</u> Ft/Sec	2
(X ₁₁) Stream Width	<u>6.2</u> Feet	1

776 / m²

$$F = (X_3)(X_4)(X_9)(X_{10}) = (2)(1)(1)(2) = 4$$

$$S = (X_7)(X_8)(X_{11}) = (4)(3)(1) = 12$$

$$\log_{10} (\hat{Y}+1) = [(-0.903) + (0.807) \log_{10} (X_1+1) + (0.877) \log_{10} (X_2+1) + (1.233) \log_{10} (X_3+1) + (0.631) \log_{10} (F+1) + (0.182) \log_{10} (S+1)] [1.12085] = 1.343$$

$$\hat{Y} = \text{antilog}_{10} 1.343 (1.12085) - 1.0 = \text{_____ kg/hectare}$$

$$22 - 1.0 = 21 \text{ lbs/acre}$$

HABITAT QUALITY INDEX (HQI) DATA FORM

Stream: Porcupine Creek P-1 Location: above culvert

Date Data Collected: 7/12/82 HQI Score = 39 = Lbs/Acre

Trout Standing Crop: _____ Lbs/Acre 42 Trout Habitat Units (x 1.0%)

ATTRIBUTE (Symbol)	DATA	RATING
(X ₁) Late Summer Flow		3
(X ₂) Annual Flow Variation		3
(X ₃) Maximum Summer Stream Temperature	<u>6</u> °C at 12:00pm	2
(X ₄) Nitrate Nitrogen	<u>2.02</u> mg/l	1
(X ₅) Fish Food Abundance	_____ Organisms/ Square Foot	
(X ₆) Fish Food Diversity	Ds = _____	
(X ₇) Cover	<u>50</u> % of Total Area	3
(X ₈) Eroding Stream Banks (Bank Stability)	<u>27.6</u> %	2
(X ₉) Substrate	<u>356</u> /ft ²	3
(X ₁₀) Water Velocity	<u>0.54</u> Ft/Sec	2
(X ₁₁) Stream Width	<u>10.1</u> Feet	2

$$F = (X_3)(X_4)(X_9)(X_{10}) = (2)(1)(3)(2) = 12$$

$$S = (X_7)(X_8)(X_{11}) = (3)(2)(2) = 12$$

$$\log_{10} (\hat{Y}+1) = [(-0.903) + (0.807) \log_{10} (X_1+1) + (0.877) \log_{10} (X_2+1) + (1.233) \log_{10} (X_3+1) + (0.631) \log_{10} (F+1) + (0.182) \log_{10} (S+1)] [1.12085] = 1.6049$$

$$\hat{Y} = \text{antilog}_{10} \frac{1.6049 (1.12085) - 1.0}{(40.2)} = 44.1 \text{ kg/hectare}$$

$$-1.0 = 39.2 \text{ lbs/acre}$$

3827/m²

HABITAT QUALITY INDEX (HQI) DATA FORM

Stream: South Piney Creek Sp-1 Location: below Snider Basin
 Date Data Collected: 9/12/82 HQI Score = 46 = Lbs/Acre
 Trout Standing Crop: _____ Lbs/Acre 50 Trout Habitat Units

ATTRIBUTE (Symbol)	DATA	RATING
(X ₁) Late Summer Flow		3
(X ₂) Annual Flow Variation		2
(X ₃) Maximum Summer Stream Temperature	<u>7</u> °C at 9:00 am	2
(X ₄) Nitrate Nitrogen	<u>1.02</u> mg/l	1
(X ₅) Fish Food Abundance	_____ Organisms/ Square Foot	
(X ₆) Fish Food Diversity	Ds = _____	
(X ₇) Cover	<u>28.7</u> % of Total Area	2
(X ₈) Eroding Stream Banks (Bank Stability)	<u>46.3</u> %	2
(X ₉) Substrate	<u>631</u> /ft ²	4
(X ₁₀) Water Velocity	<u>1.1</u> Ft/Sec	3
(X ₁₁) Stream Width	<u>28.0</u> Feet	3

6749/m²

$$F = (X_3)(X_4)(X_9)(X_{10}) = (2)(1)(4)(3) = \underline{24}$$

$$S = (X_7)(X_8)(X_{11}) = (2)(2)(3) = \underline{12}$$

$$\log_{10} (\hat{Y}+1) = [(-0.903) + (0.807) \log_{10} (X_1+1) + (0.877) \log_{10} (X_2+1) + (1.233) \log_{10} (X_3+1) + (0.631) \log_{10} (F+1) + (0.182) \log_{10} (S+1)] [1.12085] = \underline{1.6744}$$

$$\hat{Y} = \text{antilog}_{10} \frac{1.6766}{47.2} \frac{(1.12085) - 1.0}{-1.0} = \underline{83.4} \text{ kg/hectare}$$

47.2 -1.0 46.2 lbs/acre

APPENDIX B DISCHARGE VERSUS AVAILABLE HABITAT CURVES FOR CUTTHROAT TROUT



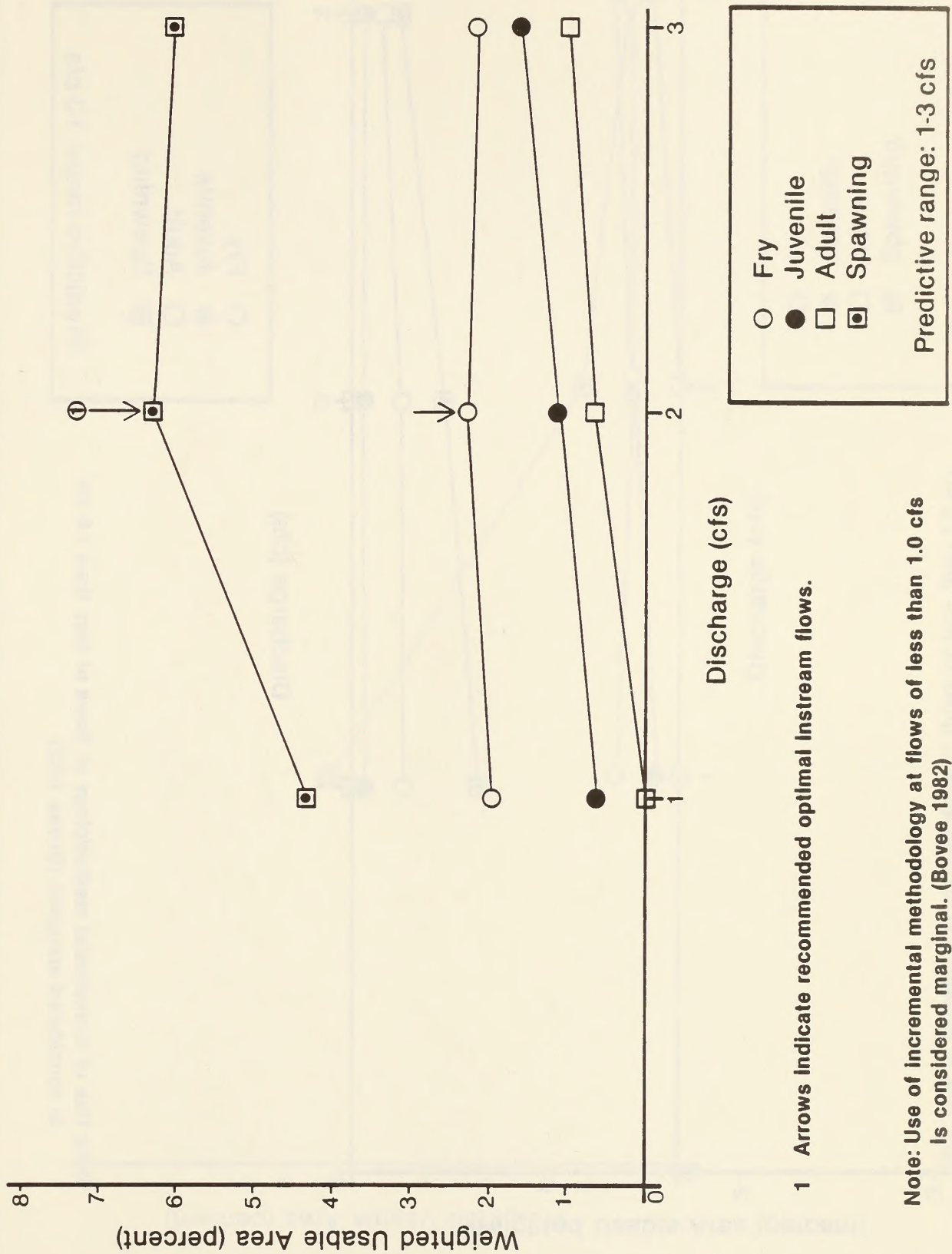


FIGURE B-1 DISCHARGE vs. AVAILABLE HABITAT FOR CUTTHROAT TROUT IN PINE GROVE CREEK (PG-1)

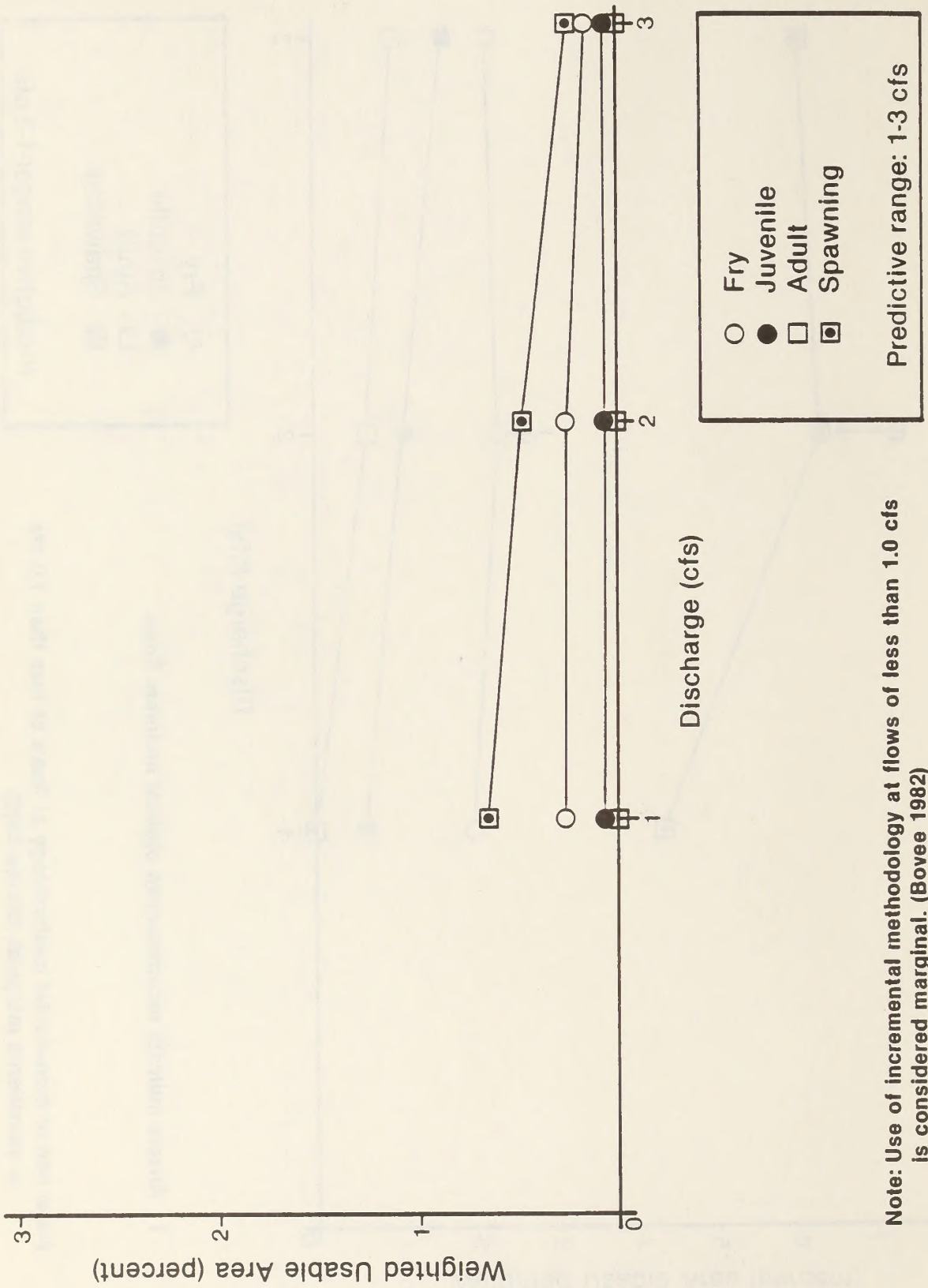


FIGURE B-2 DISCHARGE vs. AVAILABLE HABITAT FOR CUTTHROAT TROUT IN BLACK CANYON CREEK (BC-1)

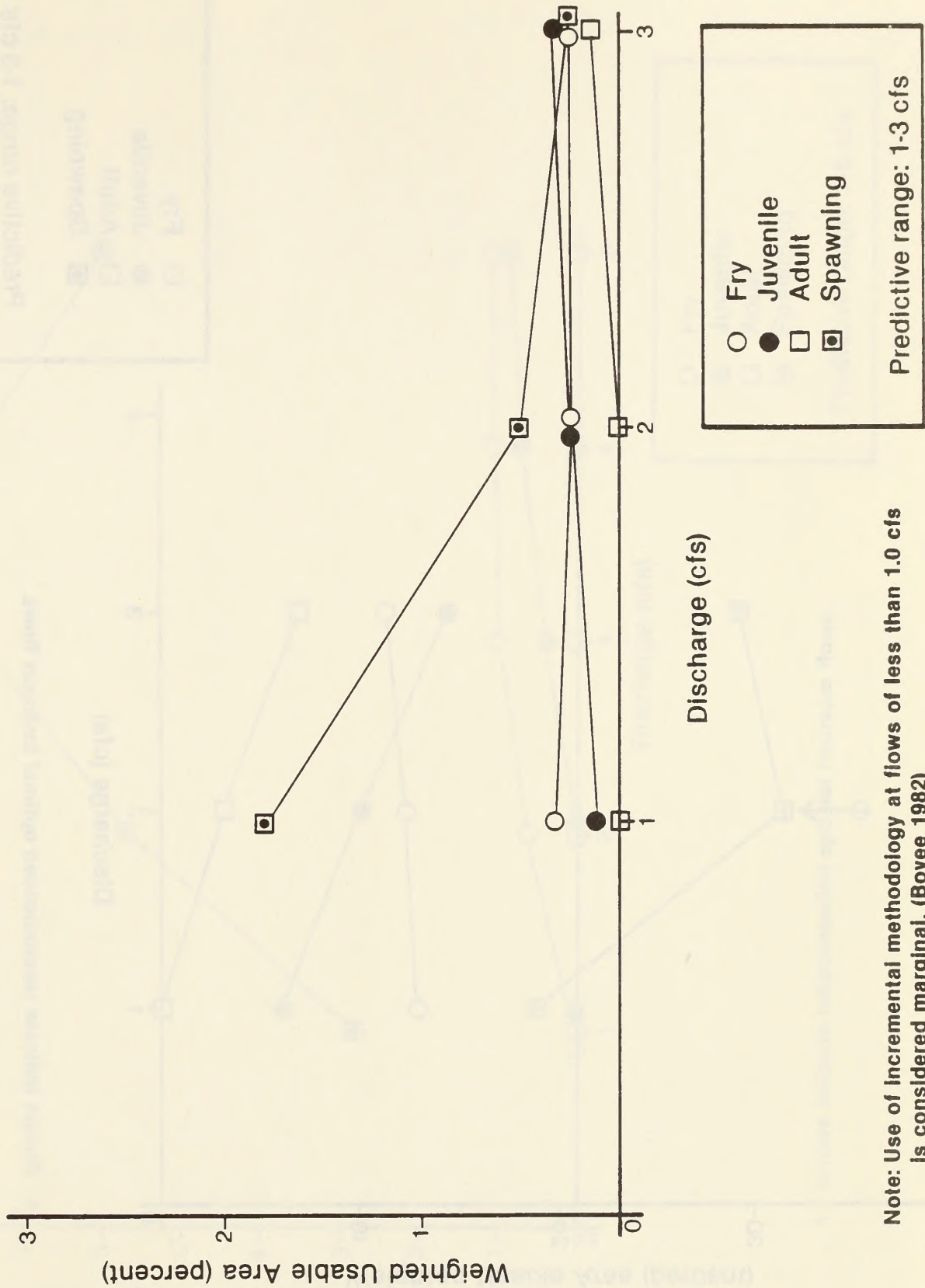


FIGURE B-3 DISCHARGE vs. AVAILABLE HABITAT FOR CUTTHROAT TROUT IN FOGARTY CREEK (FG-2)

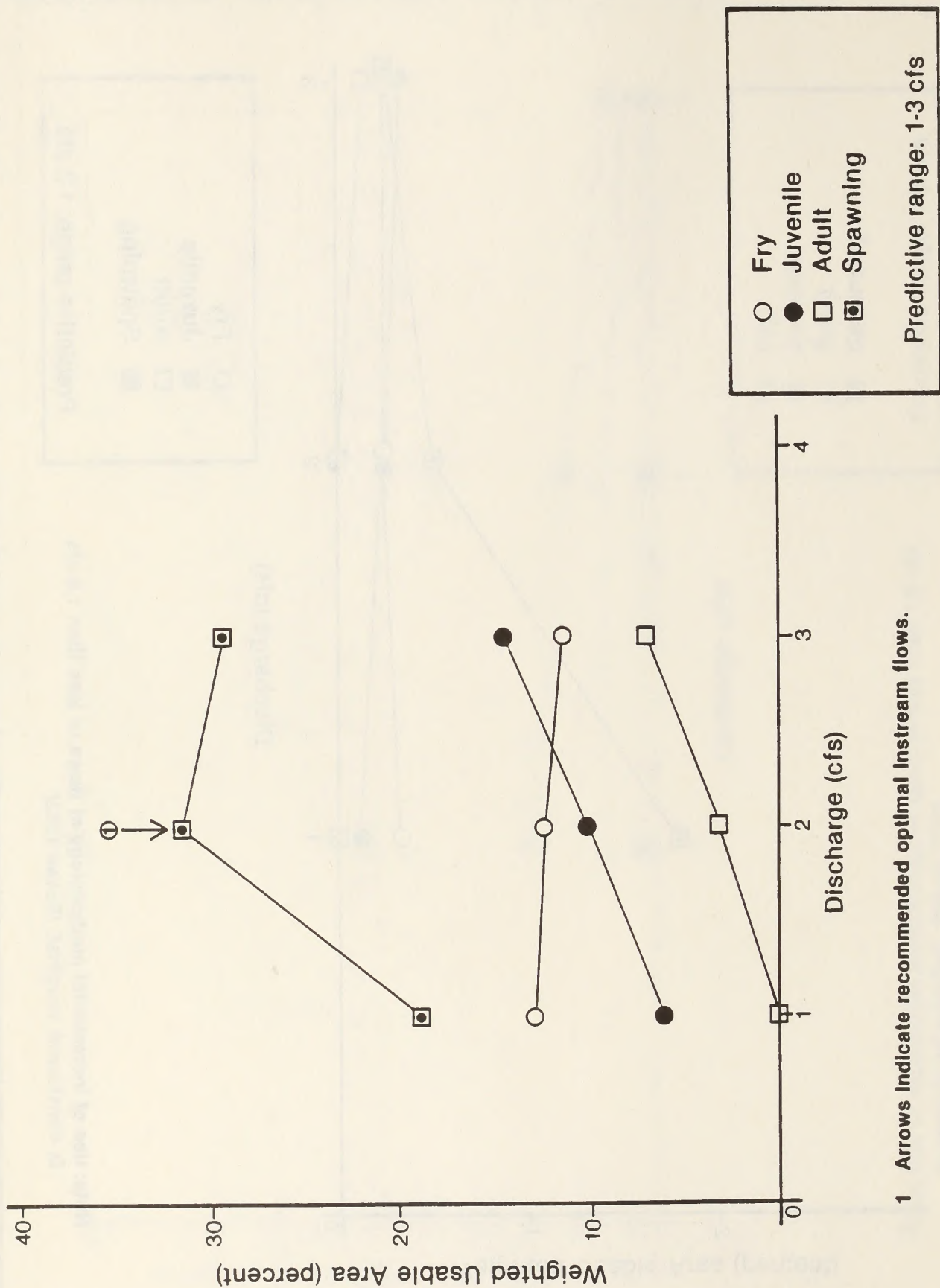


FIGURE B-4 DISCHARGE vs. AVAILABLE HABITAT FOR CUTTHROAT TROUT IN FOGARTY CREEK (FG-1)

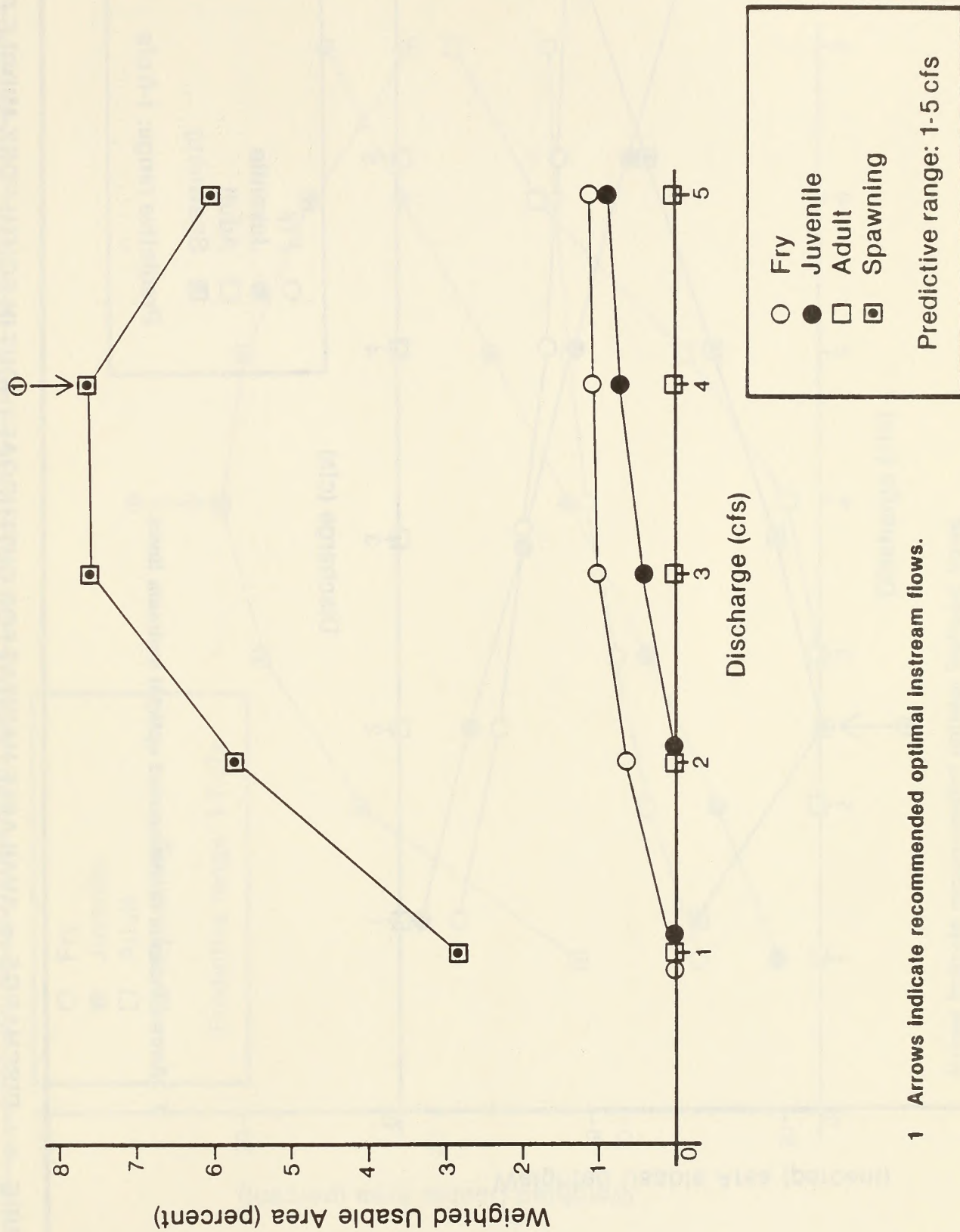


FIGURE B-5 DISCHARGE vs. AVAILABLE HABITAT FOR CUTTHROAT TROUT IN SOUTH BEAVER CREEK (SB-1)

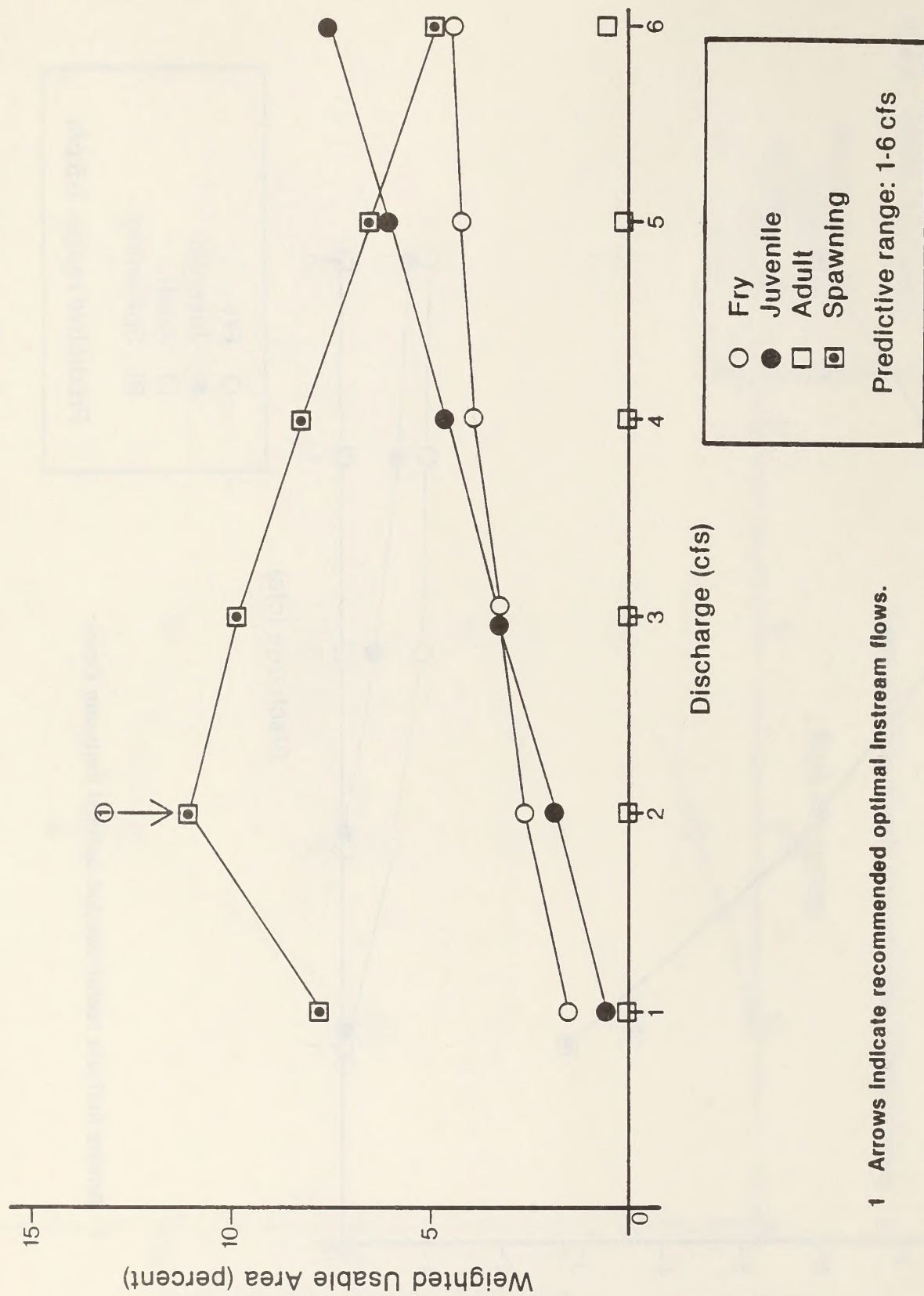
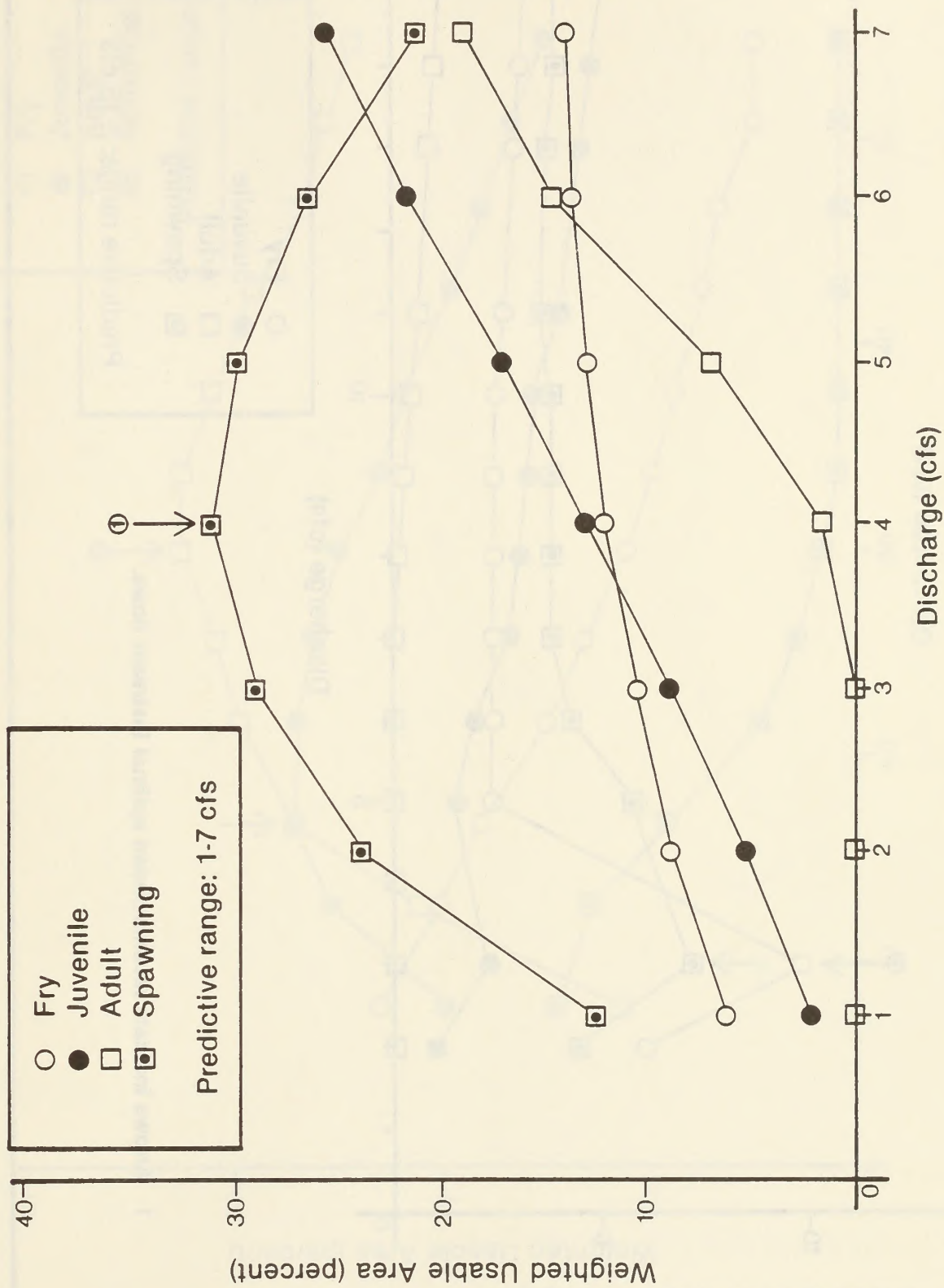
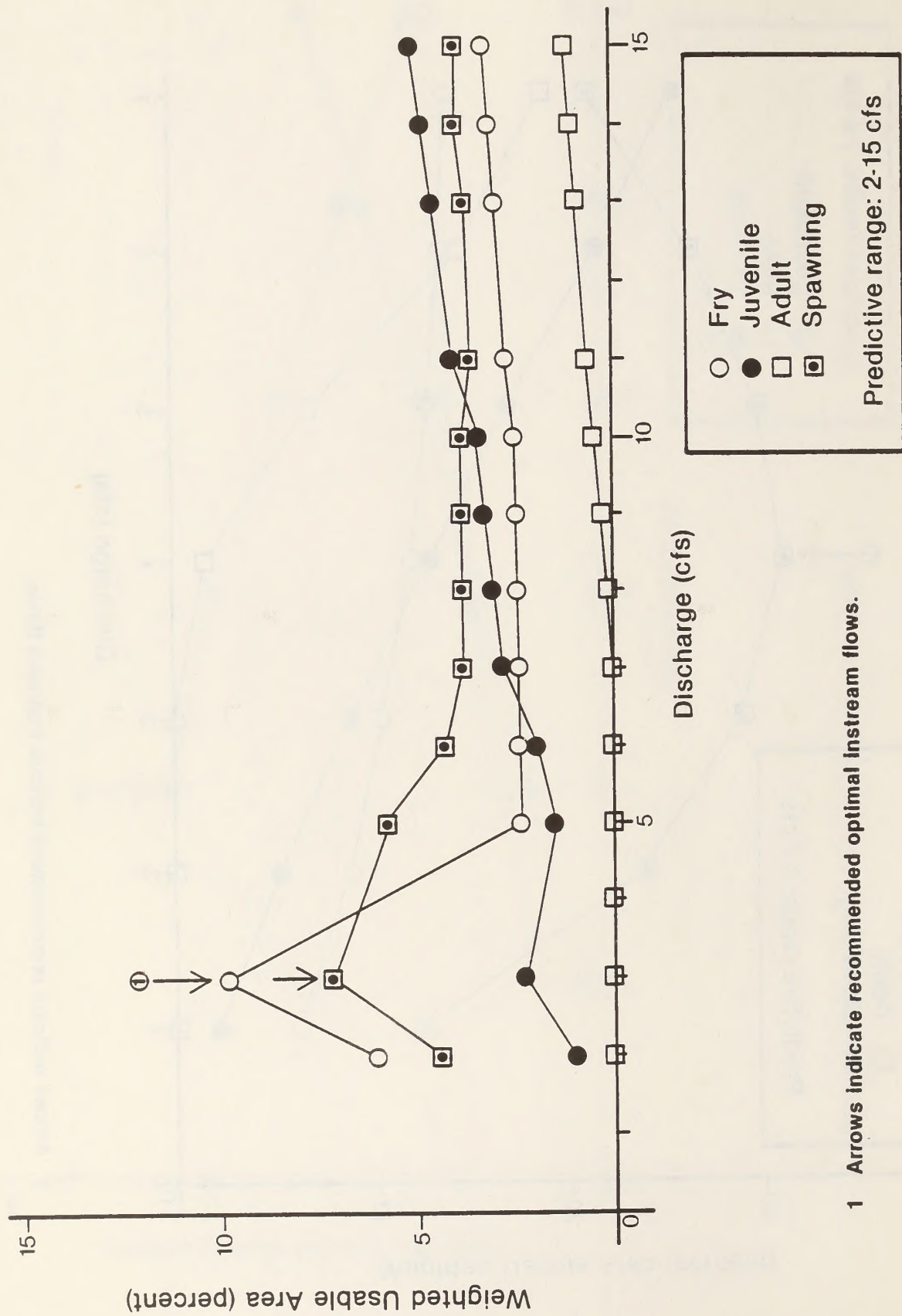


FIGURE B-6 DISCHARGE vs. AVAILABLE HABITAT FOR CUTTHROAT TROUT IN SOUTH FORK MIDDLE PINEY CREEK (SF-1)



1 Arrows indicate recommended optimal instream flows.

FIGURE B-7 DISCHARGE vs. AVAILABLE HABITAT FOR CUTTHROAT TROUT IN COAL CREEK (C-1)



1 Arrows indicate recommended optimal instream flows.

Predictive range: 2-15 cfs

FIGURE B-8 DISCHARGE vs. AVAILABLE HABITAT FOR CUTTHROAT TROUT IN BEAVER CREEK (B-1)

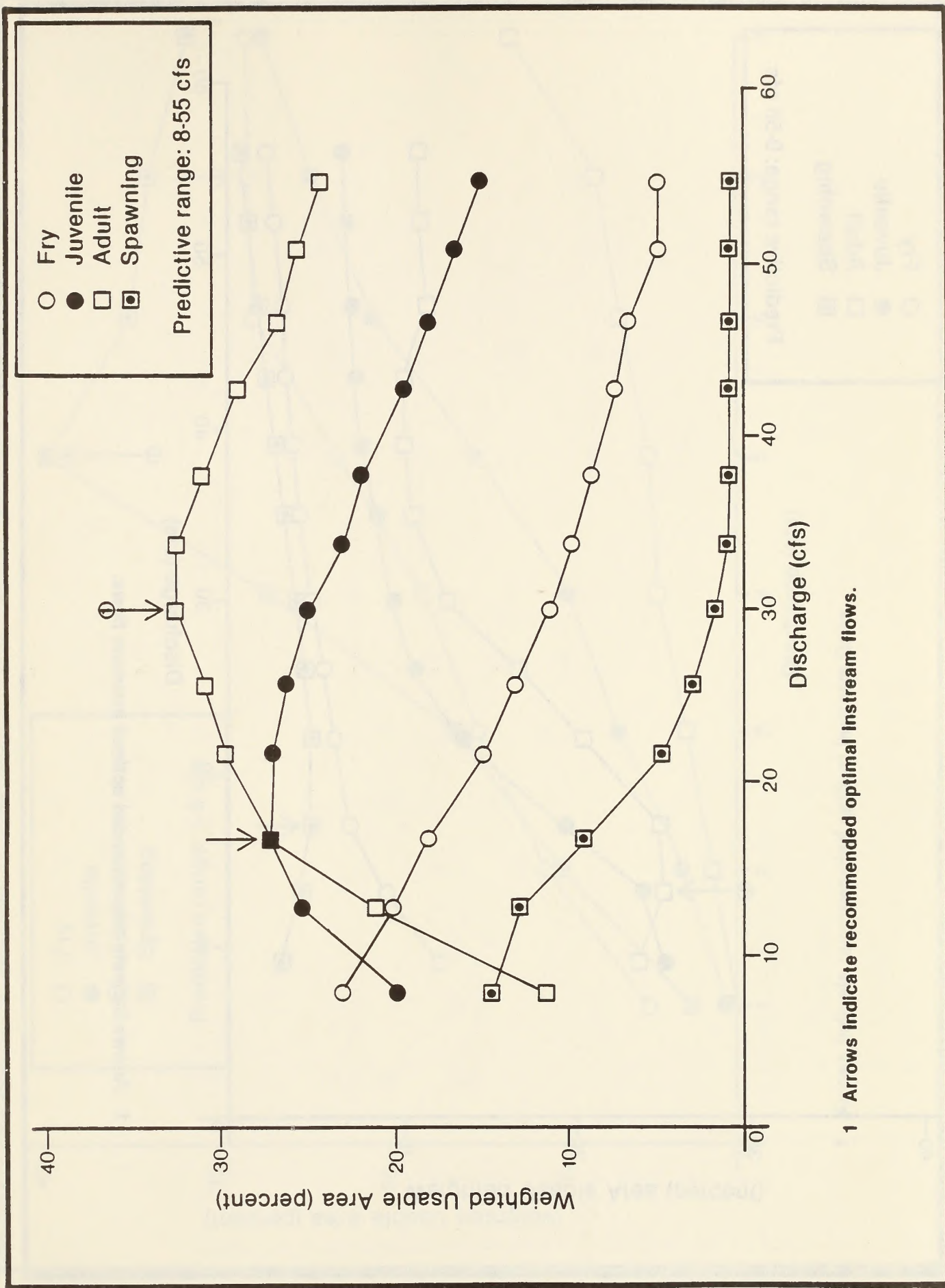
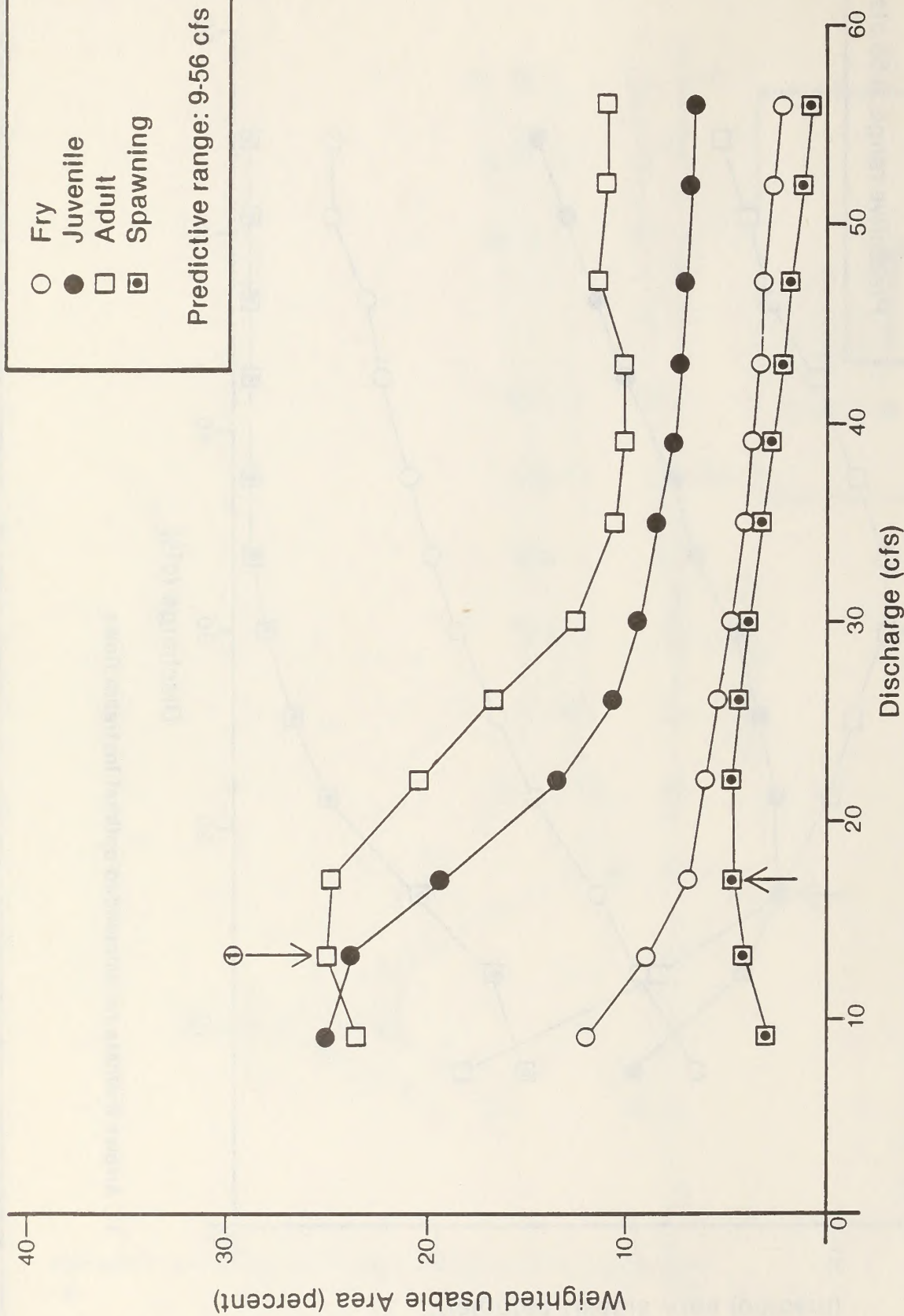


FIGURE B-9 DISCHARGE vs. AVAILABLE HABITAT FOR CUTTHROAT TROUT IN SOUTH PINEY CREEK (SP-1)



1 Arrows indicate recommended optimal instream flows.

FIGURE B-10 DISCHARGE vs. AVAILABLE HABITAT FOR CUTTHROAT TROUT IN SOUTH PINEY CREEK (SP-2)

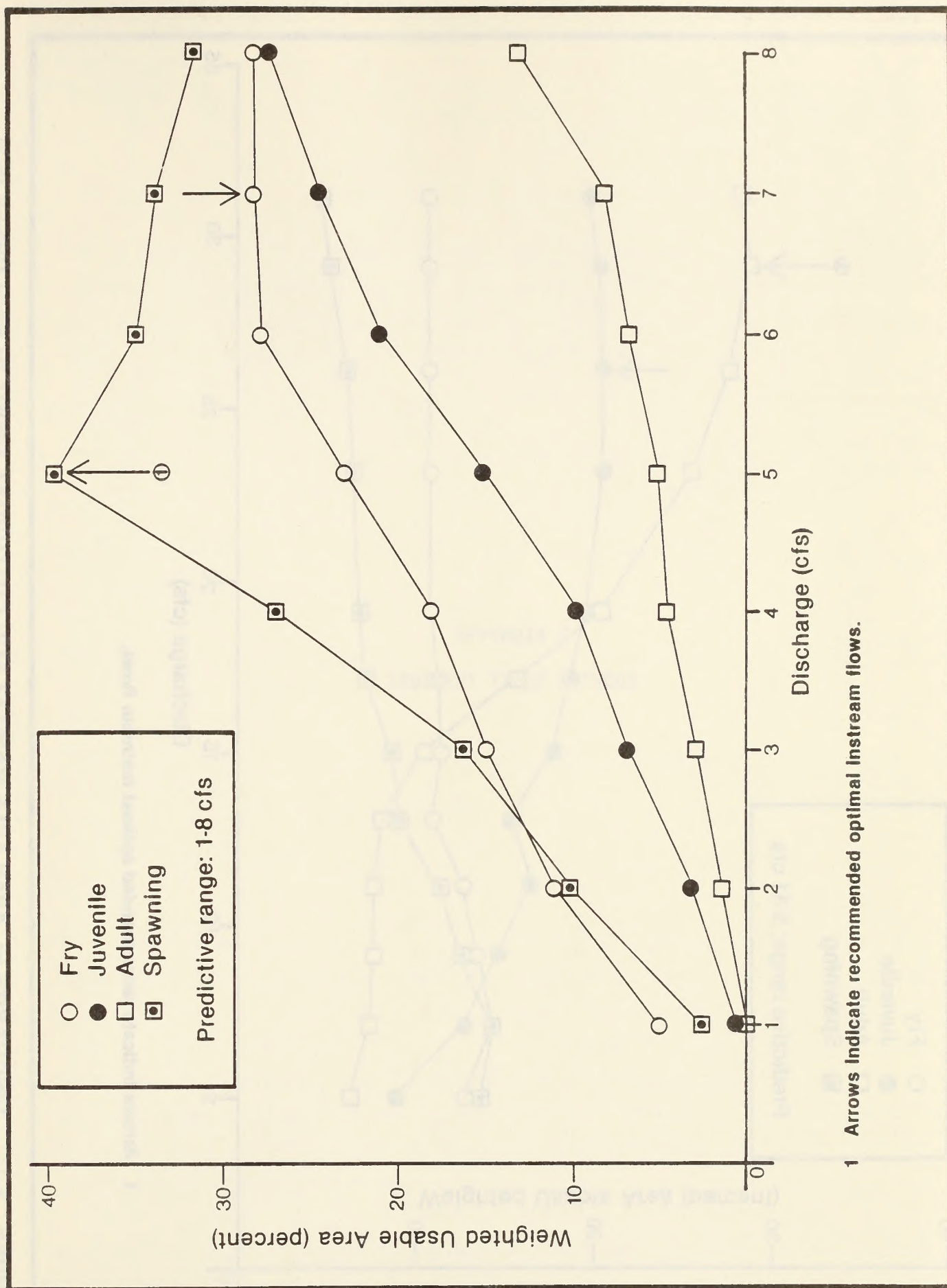
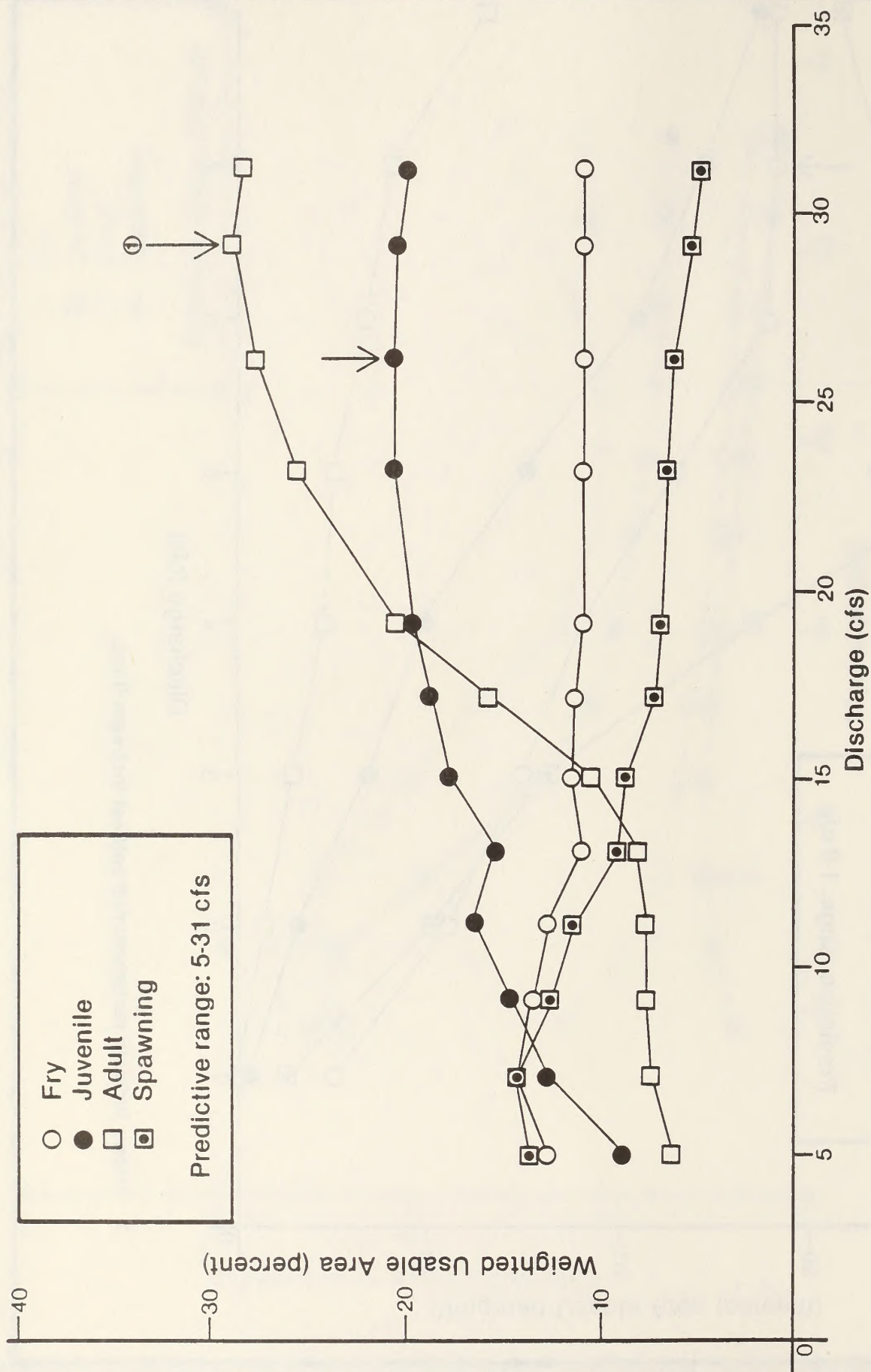


FIGURE B-11 DISCHARGE vs. AVAILABLE HABITAT FOR CUTTHROAT TROUT IN PORCUPINE CREEK (P-1)



1 Arrows indicate recommended optimal instream flows.

FIGURE B-12 DISCHARGE vs. AVAILABLE HABITAT FOR CUTTHROAT TROUT IN FISH CREEK (F-2)

SEDIMENT YIELD METHODS

SEDIMENT YIELD METHODS

The method used to estimate on-site erosion in the North Beaver Creek drainage was developed by the USDA Forest Service (Megahan 1974 and Leaf 1974). Application of the method results in time-dependent erosion indices for a given area. The process equation is:

$$(1) \quad E_t = 0.28 \tau + 401.3 (1 - e^{-0.085t})$$

Where: E = Cumulative on-site erosion (feet³/acre) at time t .

t = Elapsed time (years) since initial disturbance.

The coefficients in equation (1) were developed from research conducted in the Fraser Experimental Forest.

The equation used to calculate sediment available to adjacent streams is:

$$(2) \quad S = AE$$

Where S = Total available sediment attributable to disturbed areas (feet³).

A = Disturbed area (acres).

E = Cumulative erosion from disturbed areas (feet³/acre) from equation (1).

Equation (2) was applied for the year following construction and for five additional years. The annual sediment increments were routed to the stream channel with no assumed deposition outside the stream channel. The size fraction finer than 0.002 millimeter was assumed to be suspended, while the remainder was assumed to be deposited. Erosion was assumed to occur at a constant annual rate, and was assumed to be delivered uniformly along the stream's length. Grain size distribution was calculated from soil surveys in the North Beaver Creek area.

Estimates of average annual sediment deposition depths were made by assuming that deposition occurred uniformly within a 5-foot wide channel. Estimates

of average annual suspended sediment concentrations were made by assuming that sediment was delivered at a uniform annual rate to a stream flowing at a constant 2.5 feet³/second.

EFFECTS OF NEW ROAD AND DRILL PAD CONSTRUCTION ON NORTH BEAVER CREEK

Area = 1.47 square miles
Total Road Length = 4.0 miles
Total Stream Length = 4.1 miles
Number of Pads = 4
Pad Area = 4 pads X 1.5* acres/pad = 6.0 acres
Road Width = 40 feet including cut and fill

Year Following Construction	Eroded Material (Feet ³ /Year)	Deposited Sediment		Suspended Sediment	
		Feet ³ /Year	Inches/Year**	Feet ³ /Year	parts/ million***
1	838	612	.07	226	2.9
2	770	562	.06	208	2.6
3	709	518	.06	191	2.4
4	650	475	.05	176	2.2
5	597	436	.05	161	2.0
6	551	402	.05	149	1.9

*A reduction factor of 35 percent was applied to the operational well pad size to account for decreased erosion rates on level ground.

**Assumes 5-foot wide main channel.

***Assumes constant discharge of 2.5 feet³/second.

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As a supplement to information presented in the Wildlife Technical Report and the Draft Riley Ridge Environmental Impact Statement, additional sage grouse and raptor nest studies were conducted during the spring of 1983.

Aerial surveys were performed in the Riley Ridge well field study area and appropriate portions of the linear facilities corridors during the week of May 2 - 8, 1983. Only one active strutting ground was found within the Riley Ridge well field study area. It was located in Section 28, Township 29 North, Range 113 West, in the Tip Top Unit. There were approximately 40 male grouse observed on this ground. Two smaller strutting grounds were located adjacent to each other, (mapped as one ground), just on the well field boundary in Section 3, Township 28 North, Range 113 West. One other active strutting ground was reported about two miles east of the Hogsback Unit by an oil and gas worker in the La Barge Field. Technical Addendum Map 1 depicts these strutting grounds and other known historical strutting grounds. No other strutting grounds are known to be active within the well field (Johnson 1983, personal communication).

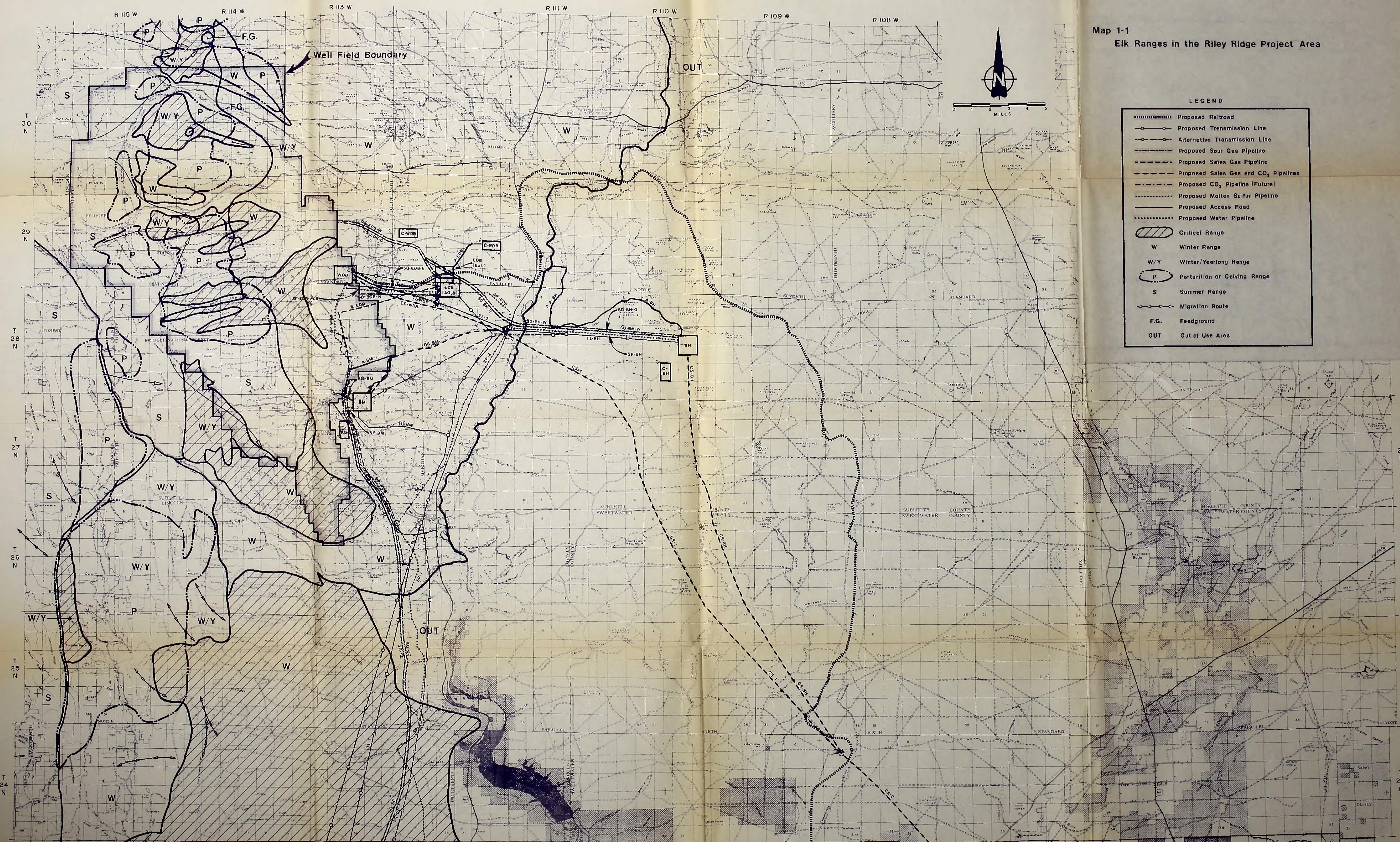
Other known sage grouse strutting grounds along linear facilities are also presented on Map 1. These strutting ground locations were compiled from historical information obtained from the Wyoming Game and Fish Department biologists in Big Piney and Green River, and BLM Resource Area Offices in Pinedale, Kemmerer, and Rock Springs. A total of 60 strutting grounds have been mapped for the Riley Ridge Project Area. Some of the strutting grounds shown on the map may represent historical sites only and have not been documented as active in several years. Those areas containing historical grounds should be considered as potential sage grouse reproductive areas. The specific locations of strutting grounds may no longer be accurate.

Known raptor nest locations in the project area are presented on Technical Report Addendum Map 2. There are 308 known nest sites in the project area representing 13 raptorial species. Of these, only 6 nest sites are known from the well field study area. Within the well field there are three known golden eagle nests, two known prairie falcon nests, and a goshawk nest. Only one golden eagle nest, at the south end of the Hogsback Unit, was reported active during 1983.

Mapped nest sites throughout the project area include those of the golden eagle (84 nest sites), red-tailed hawk (70), prairie falcon (50), ferruginous hawk (30), American kestrel (27), great-horned owl (20), marsh hawk (8), Swainson's hawk (8), raven (4), merlin (4), burrowing owl (1), goshawk (1), and bald eagle (1).

Many of the nest sites are situated along the Green River. These sites were compiled from information obtained from the Wyoming Game and Fish Department and BLM Resource Area Offices in Pinedale, Kemmerer, and Rock Springs. Maps maintained by Jim Dunder, BLM wildlife biologist in the Big Sandy Area Office in Rock Springs, provided the majority of the information shown on Technical Report Addendum Map 2.

Johnson, B. Wildlife Biologist, Wyoming Game and Fish Department, Big Piney District. 1982 and 1983. Personal communication with R. Sanz, ERT.

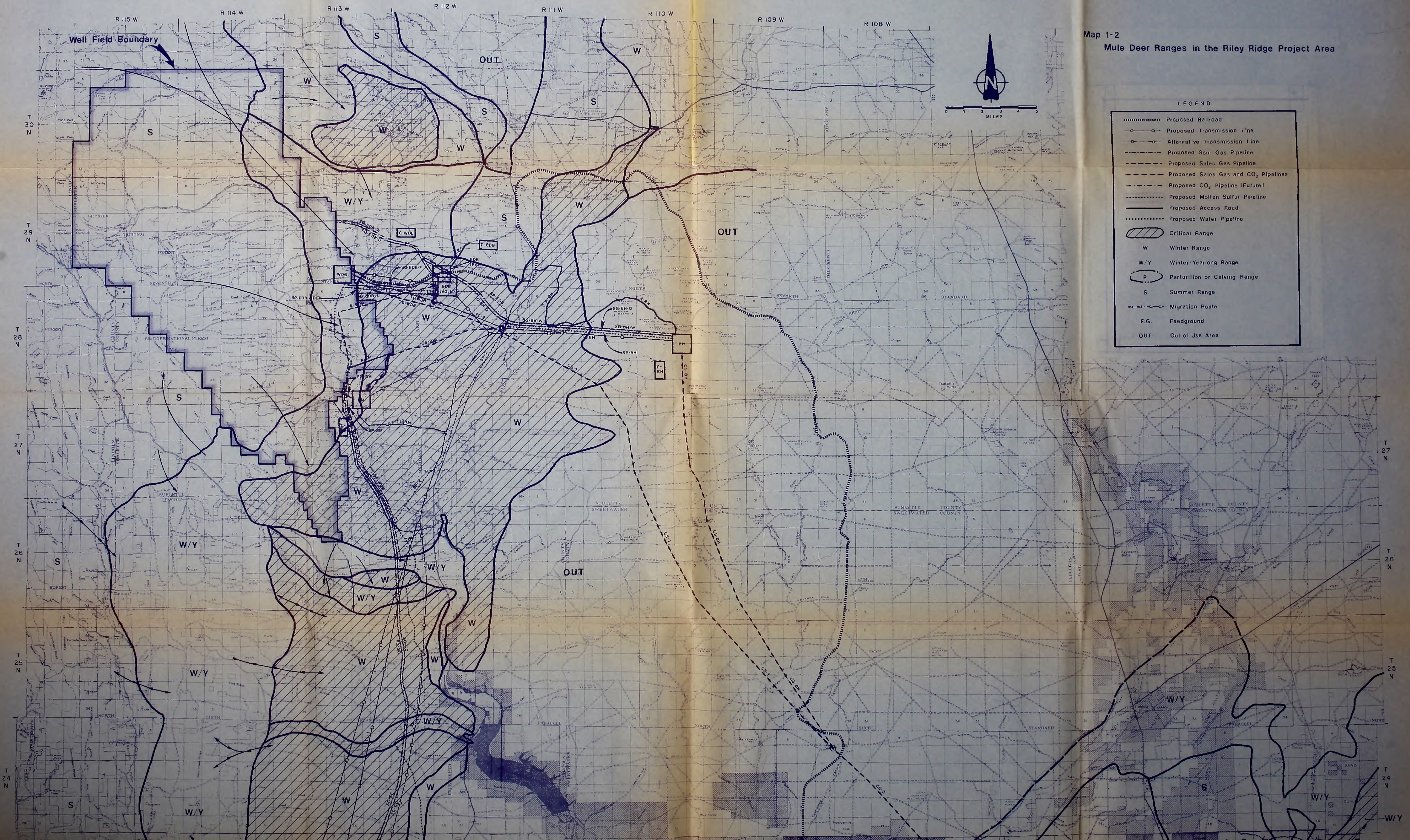


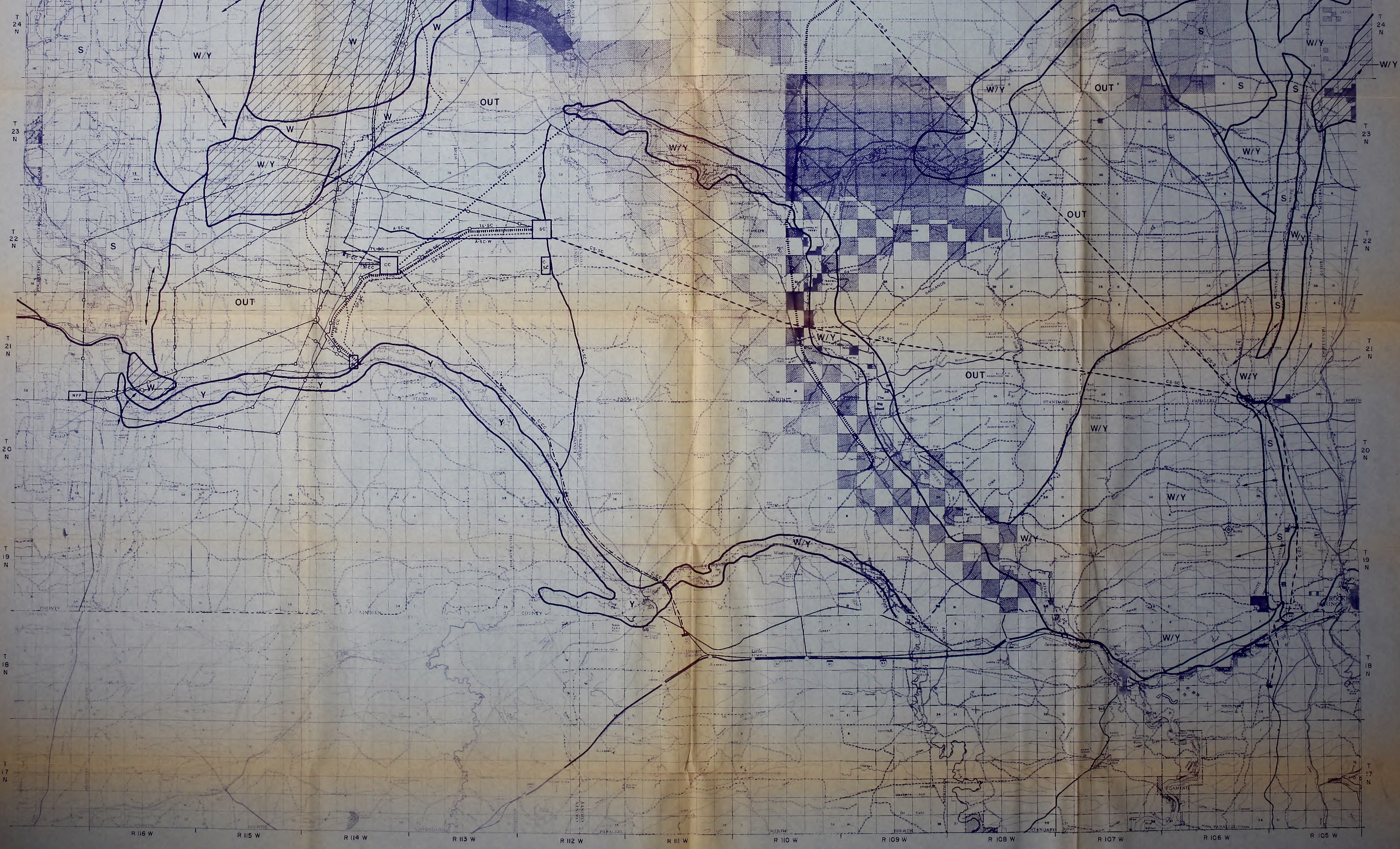
Map 1-1
Elk Ranges in the Riley Ridge Project Area

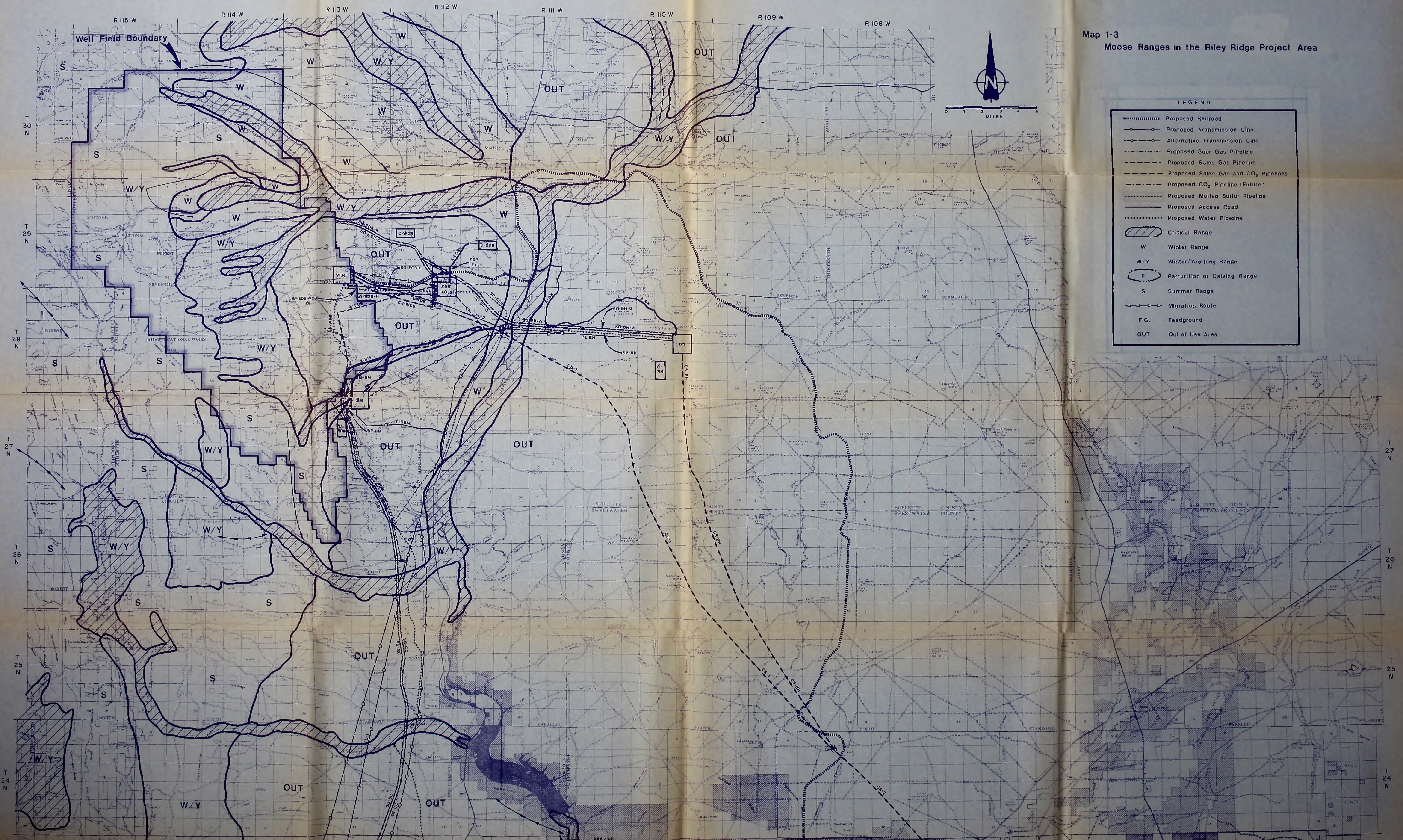
LEGEND

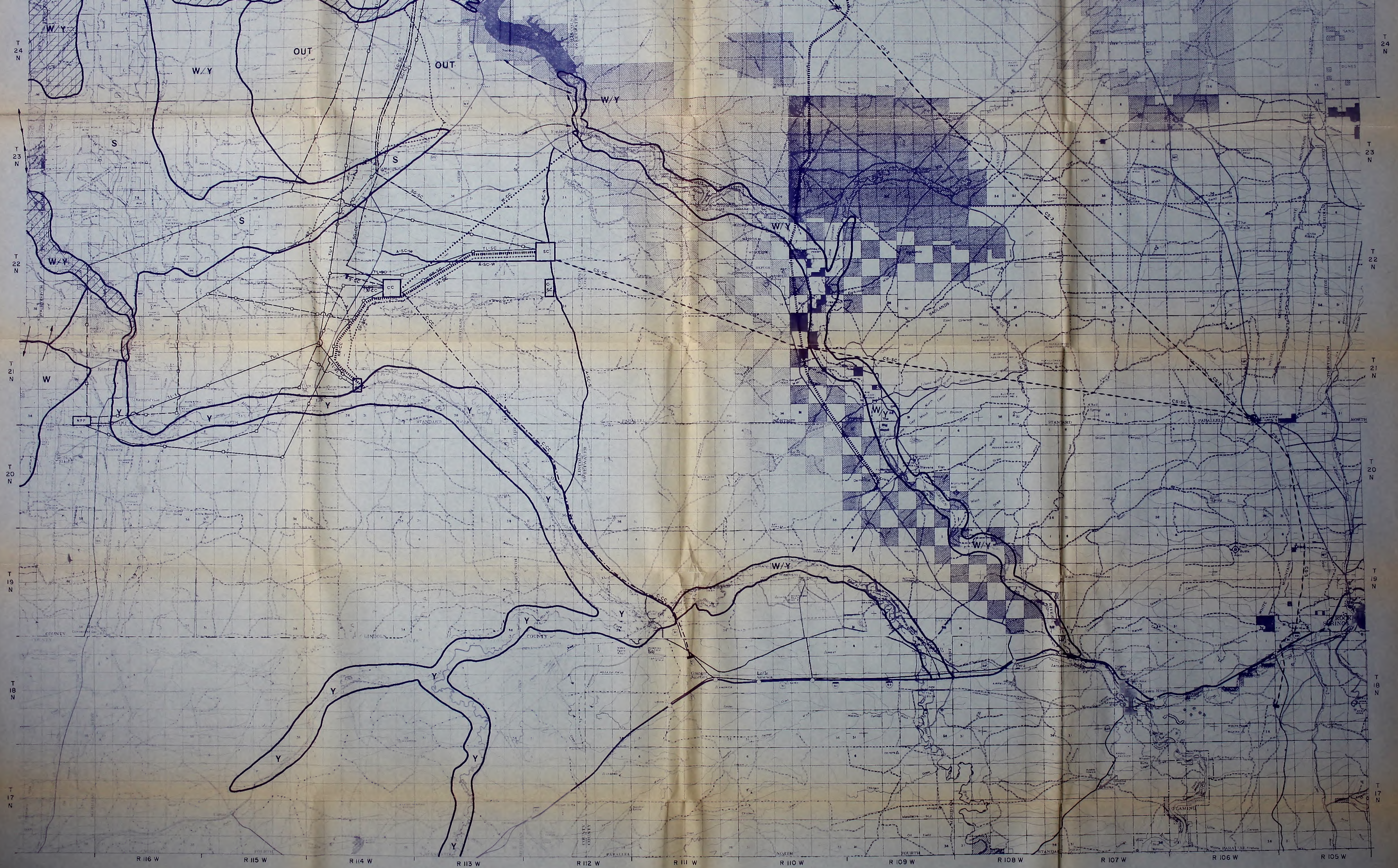
	Proposed Railroad
	Proposed Transmission Line
	Alternative Transmission Line
	Proposed Sour Gas Pipeline
	Proposed Sales Gas Pipeline
	Proposed Sales Gas and CO ₂ Pipelines
	Proposed CO ₂ Pipeline (Future)
	Proposed Molten Sulfur Pipeline
	Proposed Access Road
	Proposed Water Pipeline
	Critical Range
	Winter Range
	Winter/Yearlong Range
	Parturition or Calving Range
	Summer Range
	Migration Route
	Feedground
	Out of Use Area

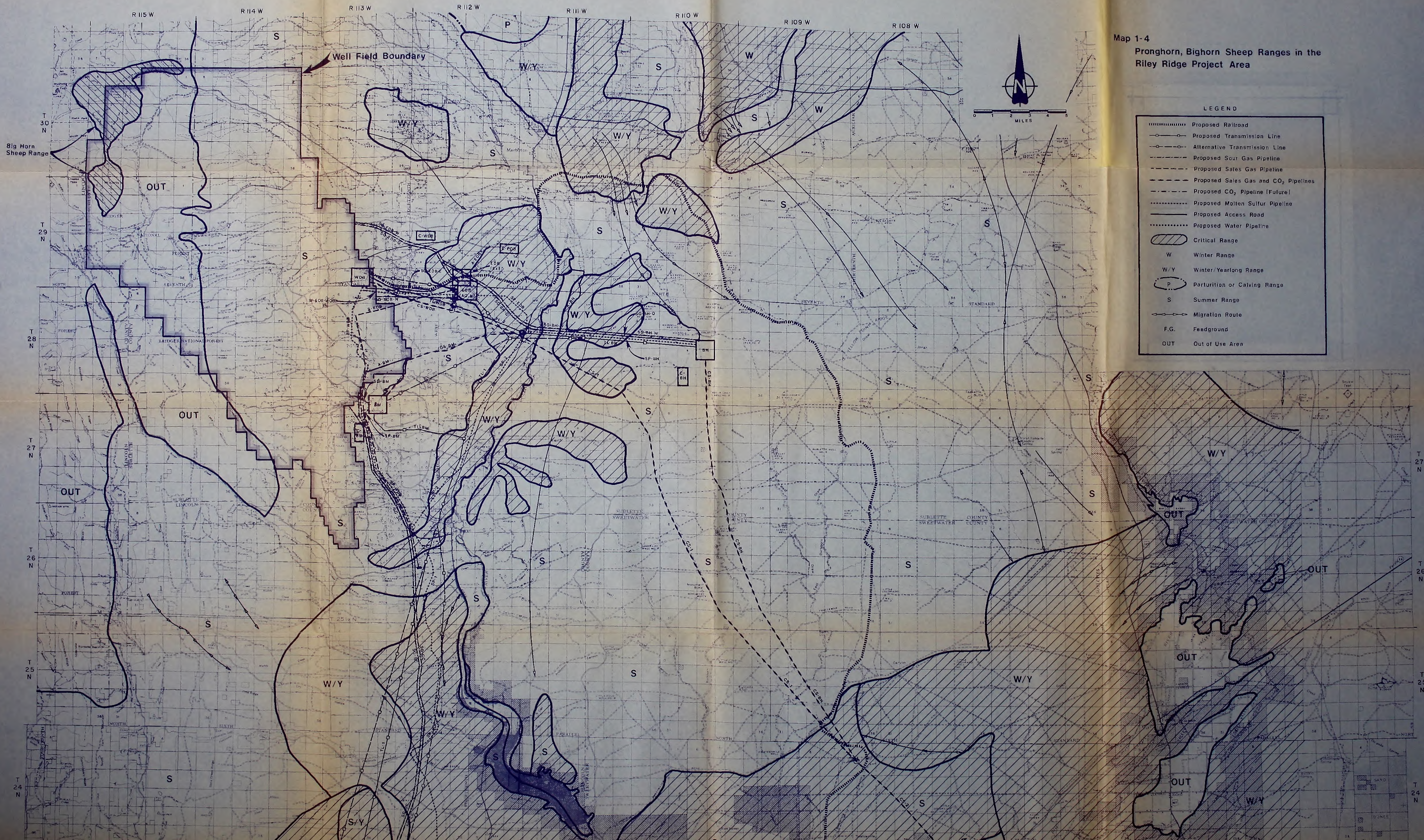












Map 1-4
Pronghorn, Bighorn Sheep Ranges in the
Riley Ridge Project Area

LEGEND

	Proposed Railroad
	Proposed Transmission Line
	Alternative Transmission Line
	Proposed Sour Gas Pipeline
	Proposed Sales Gas Pipeline
	Proposed Sales Gas and CO ₂ Pipelines
	Proposed CO ₂ Pipeline (Future)
	Proposed Molten Sulfur Pipeline
	Proposed Access Road
	Proposed Water Pipeline
	Critical Range
W	Winter Range
W/Y	Winter/Yearlong Range
P	Parturition or Calving Range
S	Summer Range
	Migration Route
F.G.	Feedground
OUT	Out of Use Area



Map 1-5
Endangered Species Habitats in the Riley Ridge Project Area





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Riley Ridge natural gas
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